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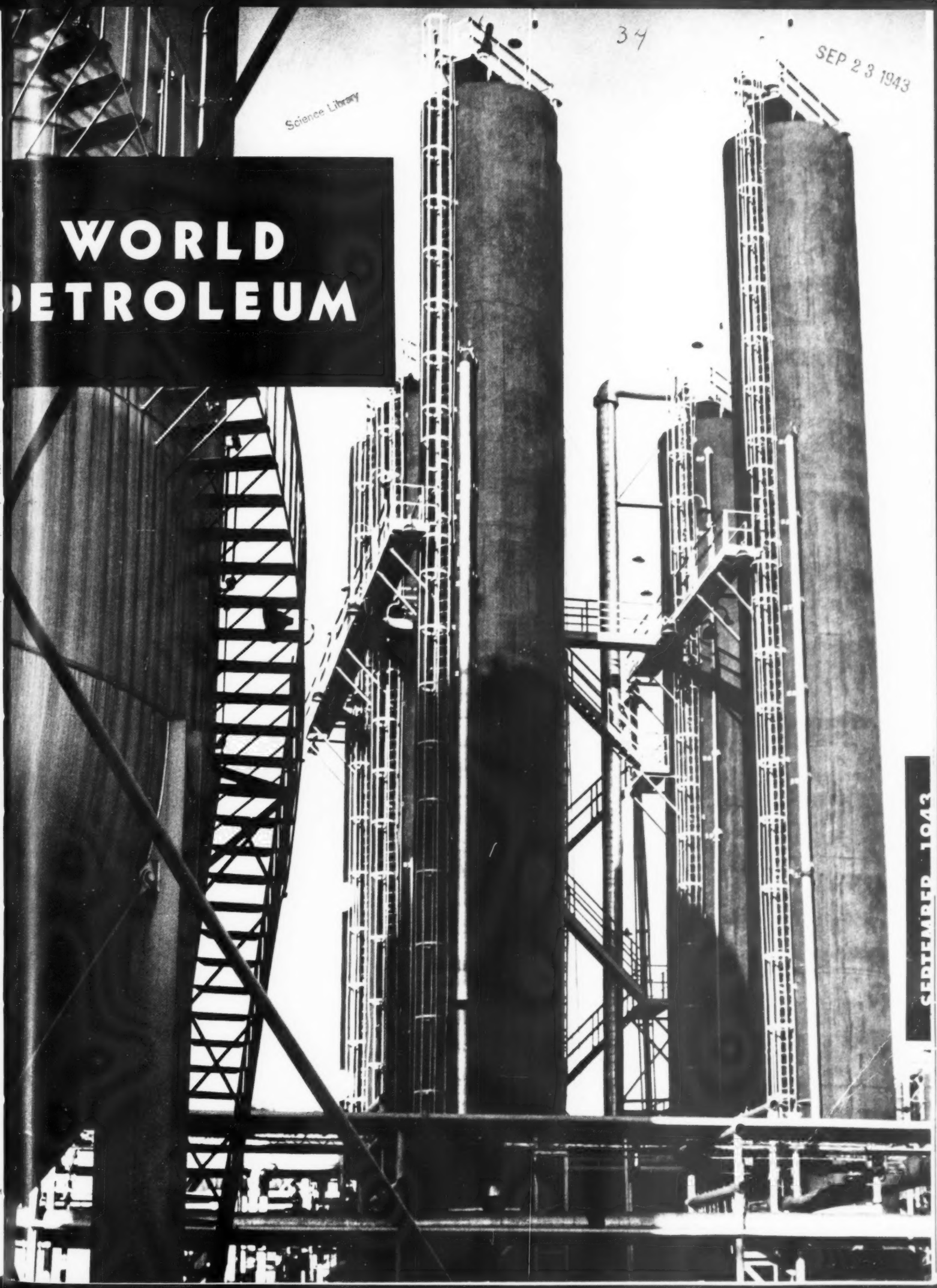

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WORLD PETROLEUM

INCORPORATING PETROLEUM EQUIPMENT EXPORTER

THE MANAGEMENT PUBLICATION OF THE INTERNATIONAL PETROLEUM INDUSTRY

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Rex W. Wadman
General Manager

E. W. Mayo
Editor

Victor N. Raiser
Advertising Manager

Agnes M. Petersen
Production Manager

Jack Selden
Art Director

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Pictorial recording of activity around super heat boilers of one of Superior Oil Company's California wells.

EDITORIAL

POST WAR EXPANSION BEFORE INTERNATIONAL OIL INDUSTRY

WHILE it is customary to refer to the conflict that raged over a large part of Europe a quarter-century ago as World War I the appelation is a misnomer.

In actuality the struggle now under way is the first world-wide war, extending to every quarter of the globe, being fought above, on and under all the oceans, and involving all but a few scattered nations. Its battle fronts have been set up in the most distant sections of the South Pacific, among fog-bound Arctic islands, in African deserts and where furthest East and furthest West come together. Its supply lines cross the Dark Continent, the mountain guarded interior of Asia and the ice bound waters of the Far North. Even the peoples who take no part in active combat have become familiar with the methods of total destruction by which the war is carried on. They know its symbols — the powerful forts that fly through the air, the mobile weapons that crush all ordinary resistance in their progress, the omnipresent gasoline can.

It is inevitable that the experiences and the contacts of the war will have a profound influence upon the future of the international oil industry, that the nomad of the East will abandon his historic ship of the desert for the more speedy and no less uncomfortable jeep, that the spade and wooden plow no longer will satisfy the primitive farmer who has seen the wonders that powerful tractors can perform, or that the inhabitants of remote localities indifferent to earlier developments of the motor age will insist upon becoming at least way stations on the systems of air transport that will cobweb the skies in every part of the world. Without indulging in the fanciful dreams of those imaginative persons who vision the daily commuter taking off for business by helicopter from his own backyard or who picture aeroflivers skipping along the highways or skimming over the countryside at will like swarms of locusts, it is easy to foresee that oil will play a more important part and be in greater demand in the post-war world than ever before. The great advance in the speed and carrying capacity of planes will make possible the operation of air services over routes commercially impracticable heretofore. So called backward nations that have seen the advantages of motor highways will want such roads and machines to operate over them. Among the large-scale activities to follow this war one of the first to be undertaken will be a vast extension and revision of the means of surface transportation. Industrial activities brought into existence in new areas by the demands of war will continue to expand and in turn will extend the markets for petroleum. A whole group of new industries created by the progress of chemical research will create new demands and provide new outlets for oil and oil products.

Growing needs undoubtedly will inspire greater efforts to satisfy them. Governments as well as private interests in every country, impressed by the national value of petroleum resources, are planning now to encourage energetic search for oil deposits or the more active development of fields they now possess. Those who fear a plethora of oil as a result of such activities may well reflect that much time and labor, large investments and direction by technical knowledge with which the world is by no means oversupplied are all required to bring success to such endeavors. Great activity does not insure immediate great results. Judging by experience the demand for oil will continue to keep well apace with supply or somewhat ahead of it as it always has except for relatively brief periods.

More urgent than the demand for oil will be the pressure for the materials and machinery required to locate it and to convert it to a wide range of usable products. The available supply of these materials and of men trained to handle them probably will be the limiting factor in the rate of expansion. The manufacturers of oil industry equipment, the owners of improved processes, the explorers, engineers and experienced operators, will face an insistent demand for their products and their services for years to come. Their first task will be to repair the damage wrought by the war itself, to reopen ravaged fields, rebuild destroyed pipe lines and refineries and resume the work of exploration interrupted by the call to arms. So vast has been the destruction, which is still going on, that the replacement of lost or obsolete facilities will constitute a task of huge proportions. When we add to that the new activities that will be called for in areas untouched by the war, it appears as certain as anything in the future can be that the men of the oil and oil equipment industries will face demands from so many directions that problems of idleness and unemployment will be their least worries.

There is little basis for believing that the war will revolutionize the oil industry. Changes in engines and in their fuel requirements undoubtedly will take place but they will come about gradually as in the past. New products will emerge and will find places for themselves. Progress will continue and will make itself felt in new directions, but in general the shape of things to come in the oil industry will not differ intrinsically from that which has characterized its past history. A realistic view of events now in the making, however, points clearly to an era of greater activity, of increased world demand and of consequent greater volume of traffic ahead. The post-war world will attain a degree of industrial efficiency never before equalled and in it petroleum will occupy a place of primary importance as a means of realizing that result.

Refining Plants on the Panuco River near Tampico, Mexico.

EXPORT DEMAND FOR EQUIPMENT
Results from Changed War Conditions

Decision to Utilize Outside Sources of Oil to Help Meet Growing Military Demands Makes Necessary Supply of Petroleum Equipment

Decision of high ranking military officers charged with management of supply services for the forces of the United States and its allies to draw increasingly upon other countries for petroleum products demanded by the war presages important changes in the international oil picture. It results in part of course from the transformation in the Mediterranean situation opening that great marine highway to the undisturbed movement of ships of the United Nations and from the reduction of the submarine menace in the Atlantic. In part it arises from a realization that the continued rapid rise in war demands if it is to be met entirely from the United States may interfere with the country's industrial efficiency and detract from its ability to produce adequate supplies of other needed war materials.

From the purely military point of view it is obviously desirable to employ the producing and refining facilities that are or can be made available in ways that will conserve transportation and provide needed supplies at points which can most conveniently serve the many fronts located in different parts of the globe. Adoption of this policy does not mean that there will be a decrease in the quantity of oil products that the United States will be called upon to provide for military use, but rather that in meeting the further growth in demand the burden will be divided among a larger number of producing and refining areas.

To the international oil industry the change will mean that certain important producing districts where output has been severely curtailed will have the opportunity to return to more normal conditions while in other areas which have not experienced a similar interruption an expansion in operations will take place. A number of steps toward the implementation of this enlarged program have been taken in Washington during the past two months. One of these was the setting up of a Program Division in the Office of Petroleum Administration with Stewart P. Coleman as director. Mr. Coleman, formerly director of the department of economics of Standard Oil Co. (N. J.) has been serving for the past year as chairman of the sub-committee of the Economics Committee of the Petroleum Industry War Council. This committee has been actively engaged in the study of oil supply problems both for war requirements and domestic needs and Mr. Cole-

man's transfer to the Office of Petroleum Administration signalizes the decision to carry on similar work on a broader scale with the added authority that comes from having it conducted by an official agency of the government.

In defining the function of the Program Division Ralph K. Davies, Deputy Petroleum Administrator for War said:

"As the United Nations shift to the offensive on a global scale petroleum becomes the most important single commodity required by our armed forces, its tonnage approximating the total tonnage of all other war supplies combined. Both the military operations and the accompanying petroleum supply operations are international in scope and it becomes increasingly necessary to develop a tightly knit and closely coordinated petroleum supply program to meet the military and essential supply programs of the United Nations."

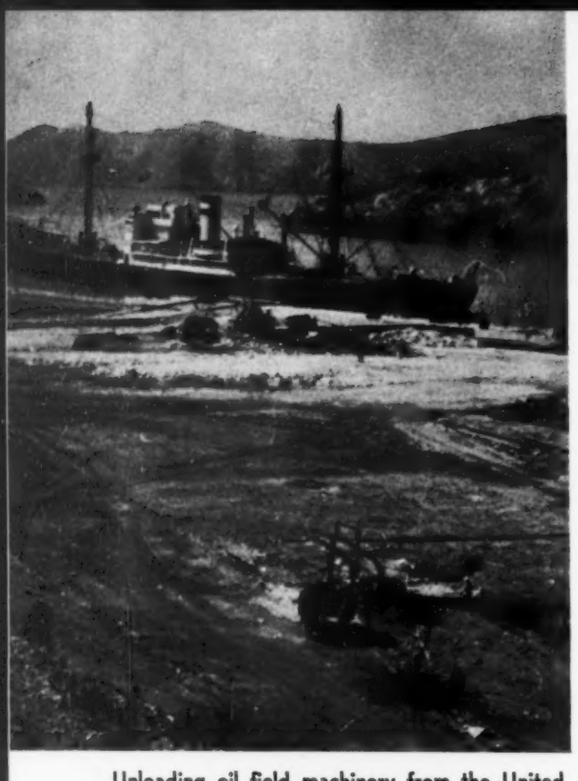
Mr. Davies further explained that the Program Division would consult the suggestions of the Petroleum Industry War Council, which previously had recommended the fuller employment in war activities of the available petroleum resources of the United Nations, and the Foreign Operations Committee as a basis for such action as might need to be taken by the Petroleum Administration for War in fitting its activities into an international plan of operations.

Another development of potential significance has been the organization of Petroleum Reserves Corporation, a government-owned company about which very little information has been divulged. The corporation is authorized to engage in a very broad range of activities and the general understanding in Washington is that its purpose is to put the financial strength of the government behind the development of petroleum production or the provision of processing facilities whenever and wherever it may be deemed that the requirements of the war make such a course necessary. If this interpretation is correct it means that Petroleum Reserves Corporation may engage in the production, refining and transportation of oil in any part of the world, possibly along the same lines followed by Defense Plants Corporation within the U. S. in connection with the construction of munitions plants and in carrying out the synthetic rubber program.

Meanwhile the insistence of the military authorities on prompt action to provide supplies from sources other than the United States has had a more immediate effect in another direction. It has led to the release of petroleum equipment for export and the promise of shipping space for the movement of such equipment to places where it can be used to advantage. Under present circumstances the United States is practically the only available source for the supply of oil machinery and the lightening of the embargo which has virtually closed outside markets to American manufacturers for the past two years has brought about a decided spurt in export activity. Some orders that have been on the books of machinery

Drilling in Mene Grande's Oficina field in Eastern Venezuela showing sand line coming off a cable drum. Venezuela was the world's largest pre-war exporter aside from the United States.

Colombian workmen on one of the light Socony Vacuum rigs. Recent discoveries in Colombia give promise of substantial gains over past production and intensive drilling campaigns are planned.



Unloading oil field machinery from the United States for exploratory drilling in Eastern Venezuela to increase production for war needs.

fabricators for a long time are now on the way to being filled and new orders are being placed by international oil companies, particularly for field and drilling machinery. Owing to the definite turn which the course of the war has taken in recent weeks and the rising demand for petroleum products which is resulting from the enlargement of the allied offensive it is expected that more extensive releases of export materials will follow as rapidly as the demands upon steel and other critical materials for munitions and direct fighting equipment will permit. As a result of the new phase upon which the war has entered it is recognized that petroleum supplies are just as important as the planes, tanks and ships dependent upon them for fuel and in consequence the opening up of the export market for oil machinery has come more quickly than was generally anticipated.

Since military needs govern the course of action in this matter primary consideration naturally is being given to those areas in which it is possible to increase production quickly and from which transportation can be established with the least interference with existing commitments. These factors have led to the direction of earliest attention to Venezuela, Colombia and Mexico among the countries of the Western Hemisphere and the greater part of the equipment for which materials have been allocated thus far is destined to these areas.

In the period before U-boat depredations forced a drastic reduction in its shipments to the United States and across the Atlantic Venezuela's wells were producing over 600,000 bbl. per day. The country was the world's largest exporter aside from the United States. Discoveries and extensions of existing fields were constantly adding to its potential output. With the interruption of ocean transportation shutting off its customary outlets Venezuela's production had to be cut down drastically and in recent months has been running slightly under 400,000 bbl. daily.

As the greater part of Venezuela's production comes from flowing wells it is not anticipated that these will be seriously affected by the enforced shut-in but some work of rehabilitation undoubtedly will be required. Drilling, both the wildcat variety and the sinking of wells for the extension of existing fields, has been largely suspended, both because of the inability to import drilling machinery and because there was no inducement to bring in new producers when no means of taking care of the oil that they might yield was at hand. The inventories of machinery and parts which the oil companies usually carry were nearly exhausted in maintaining the operations which they found it necessary to keep up. At the present time therefore the great need is for drilling and auxilliary equipment to restore production to its normal level and to pave the way by exploration for meeting future needs that may arise. Practically all of the oil organizations now operating in Venezuela are preparing to expand their activities in this direction. One company that has had only two rigs at work intends to increase this number to fifteen as soon as the necessary equipment can be obtained. Another is preparing to add six rigs to its existing complement and others will step up their drilling operations in varying degrees. From all indications the Venezuelan fields, both East and West, will be the scene of unusual activity during the coming year.

In Colombia the situation has been affected by the same factors as in the case of Venezuela and with much the same result except that production has been reduced to a still greater degree proportionately. Prior to the encroachment of war on the Western Hemisphere Colombia's production was something over 20,000,000 bbl. yearly or at the rate of roundly 60,000 bbl. daily. This has been reduced below 12,000 bbl. daily, a decline of roundly 80 per cent. Recent discoveries of new producing areas in Colombia lend hope of a substantial increase over past production and enlarged drilling campaigns are projected by the companies operating there.

Both Venezuela and Colombia possess the advantage of having close at hand in the Netherlands West Indies two of the world's largest refineries fully equipped for the manufacture of the petroleum products in chief demand for military use from fuel oil to 100 octane gasoline. The special adaptability of crudes from the Maracaibo basin to the making of residual fuel for which there is an enormous demand for bunkering purposes is a feature of particular importance in this picture.

One of the factors making possible a greatly enlarged use of oil from the Caribbean area is the rapid expansion of tanker tonnage. Additions of new vessels to the existing tanker fleet by United States shipyards during the current year will have a combined capacity of over 4,000,000 bbl. While not all these vessels can be assigned to the South American run the tonnage that can be made available with the steadily rising margin of safety in marine operation will make possible the movement of a very large volume of oil and probably will make possible the addition of 250,000 bbl. daily to supplies from the north coast of South America as soon as production can be brought up to the point that will permit such increased shipments.

Another advantage in the location of Venezuelan and Colombian oil from the military point of view is their nearness to the Panama Canal which will make possible the diversion of shipments through that waterway to the Pacific should conditions in that combat area make such action advisable.

Relatively small quantities of oil industry equipment have been moving from the United States to Mexico during past months. Now the first important step toward the complete modernization of the Mexican industry has been taken with the placing of a contract with an American firm for the design and construction of a large refinery costing several million dollars and equipped to turn out 100 octane gasoline. Other plans under discussion provide for a large extension of exploration and drilling, the building of pipe lines and the rehabilitation of the country's entire refining plant which is admittedly in an obsolete state. Bound up with this program are proposals which may lead to the return of foreign capital to Mexican oil operations on a basis acceptable both to Mexico and foreign investors. These proposals have not yet reached a stage where anything definite can be said about them but it is obvious that the ambitious program laid down will require several years to complete and will call for a very large capital investment. In the meantime there are very definite possibilities of adding to Mexico's current output and in making supplies from this source available for Allied war operations. Mexican production which was 130,000 bbl. daily before expropriation has fallen off to 87,000 bbl. per day during the past year. This decrease has been due largely to the shutting off of exports. At the same time inability to conduct new drilling on the scale necessary to maintain the productivity of existing fields and the discovery of new ones admittedly has been a factor affecting the situation. Mexican authorities assert that with a sufficient supply of drilling machinery and related equipment from the United States it would be possible within a relatively short time to raise their daily output by 50,000 bbl. This figure of a potential addition of 300,000 bbl. daily from these three countries to available supplies for war use is known to enter into the calculations of those who are charged with the provision of a greater volume of oil supplies to

back the supreme onensive of the United Nations" and the provision of the equipment to make this expansion possible is regarded as the next big task that American manufacturers will be asked to undertake.

While early gains in production are looked for from Latin America this is not the only source from which allied collaborators in the mobilization of petroleum hope to get larger stocks of oil with which to supplement those heretofore available. As the chief of supply services for the United States forces revealed sometime ago careful consideration is being given, now that the Mediterranean has been cleared of the Axis menace to shipping, to the wider utilization of oil from the Near and Middle East including Iraq, Iran, Bahrein and other fields in that area. The figure mentioned at the time as possibly obtainable from this quarter was 200,000 bbl. and it was also pointed out that additions to refining facilities within that area would be of assistance to Allied war chiefs by increasing the supply of aviation fuel within easy reach of air forces operating in the eastern Mediterranean or of battle fronts likely to be established in that general area in the course of the war's further progress. It is generally known that one high octane unit of large capacity has been installed under Allied auspices in the Near East and that others have been under consideration.

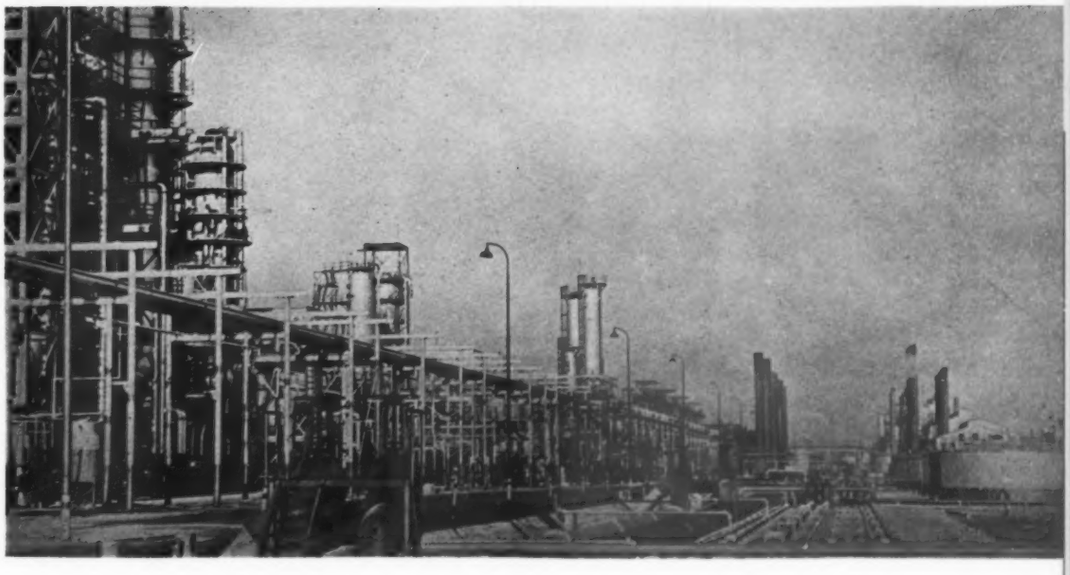
Russia too has made additions to its producing and refining facilities within the past year including four refineries of latest design to increase its output of aviation and ordinary motor fuel in order to lessen its dependence upon importation of these highly essential supplies. Now that the threat of Nazi occupation of its important fields appears to have been removed and more direct transportation routes have been opened Soviet insistence upon the delivery of additional equipment may receive early attention.

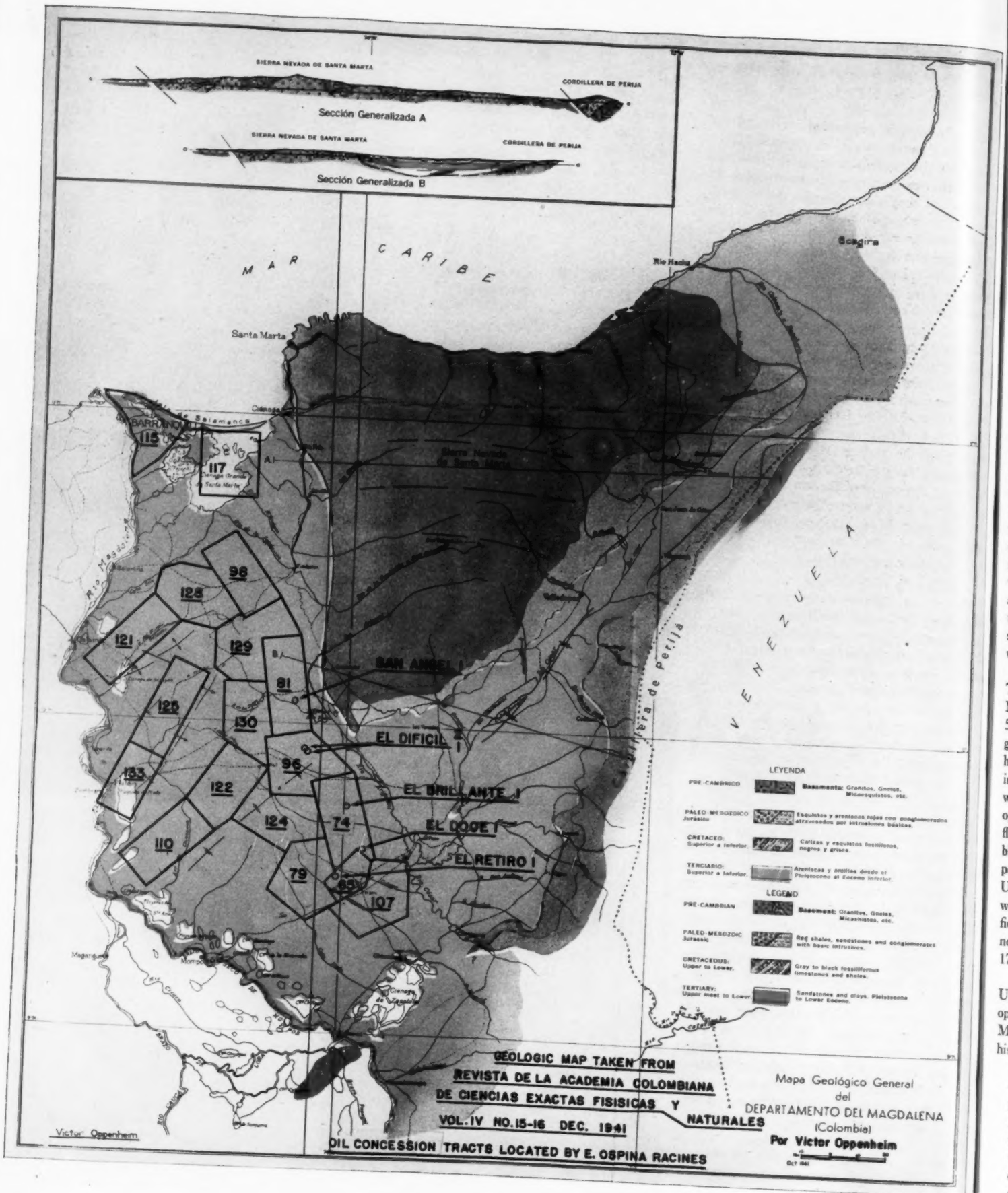
Other plans and proposals for making oil available nearer to strategic military points than either the eastern or western coasts of the American continent are being considered and in some few cases are being carried out. An example of such activity is the development of increased production at Norman Wells in northern Canada and the construction of a pipe line to convey this oil to Alaska, an enterprise that is being put through by the United States Army with the cooperation of the Canadian government. These undertakings, as in this instance, may not add greatly to the total supply of oil but possess importance by the saving effected in transportation time and equipment in delivering oil to the places where it is needed. In other parts of the world the Army is sponsoring drilling with results that as yet have not been revealed.

As the occupation of enemy held territory by Allied forces proceeds there will be opportunities for the restoration of destroyed or damaged oil facilities which then can be turned to account in helping to carry the war to a finish. The fields where such rehabilitation can take place lie mainly in the Pacific and are now in Japanese possession. The date when these areas will come under United Nations control is uncertain but advance planning is under way to deal with this situation and to have the machinery and equipment needed for the resumption of operations when the time arrives.

As a result of the turn of events in the war itself world production of oil is likely to show a substantial increase during the coming year as compared with 1942-43 with the exception of the territories of the Far East and the European countries directly embroiled in the conflict raging there. Definite measures certainly will be taken to enlarge the output of those countries which may be considered to occupy key positions in their relation to military operations by supplying them with machinery and equipment to the fullest possible extent. Thus the export demands for such equipment which has been backed up for nearly three years has been released with unexpected suddenness. From present indications this demand which appears certain to rise to unprecedented proportions following the conclusion of the war will develop at a pace sufficient to take up the slack in domestic operations within the United States as the war plants which have been under construction reach completion, releasing structural materials for other uses. Fear that the equipment industry might run into a period of depression following the completion of war product plants and before the needs of other oil producing areas could be translated into specific orders appear now to be groundless. While the United States may be overbuilt in its refining plant following the war and while a drop in its demand for equipment would appear inevitable the export trade will come into its own and will assume proportions far exceeding those of any past period.

Below: Storage tanks at Venezuela Petroleum Co. terminal.
Bottom: Giant oil refineries in Netherlands West Indies.





Map of Magdalena Department, showing oil concessions.

WILDCAT OPERATIONS YIELD ENCOURAGING RESULTS IN COLOMBIA

Shell's Discovery of Second New Field of Outstanding Interest—Magdalena District Attracting Special Attention—Fresh Finds in Barco—Concession Filings Point to Great Activity When Equipment Becomes Available.

By E. Ospina Racines
Petroleum Economist, Bogota

OUTSTANDING in Colombian wildcat operations during the past twelve month period is Shell's discovery of El Dificil field, located in a 48,569 hectare (120,000 acre) tract, some 75 miles from Caribbean tidewater, in the Magdalena department. Although the concession contract came into force on November 29, 1940, it was not until July 18, 1942 that the discovery well El Dificil 1 was spudded. The intervening period, devoted to exploratory geological and geophysical work as well as to road building, the moving of equipment to the well site and erection of a camp with the necessary hygienic conveniences, serves to gauge some of the difficulties which must be overcome in virgin wildcat country. During the first three year exploratory period, ending November of this year for this concession, the operator is obliged to spud at least one well. During the fourth year, at least two wells must be spudded, otherwise a legal situation is created whereby the concession is subject to forfeiture.

The discovery well El Dificil 1 was completed May 14, 1943 and reached a total depth of 5950 ft., having encountered the Sierra Nevada granite basement. Only a fraction of several hundred feet of pay formation was tested, working pressure of the gas amounting to 2500 p.s.i. which created hazardous conditions for testing operations. A preliminary yield, with a 1/8 inch flow bean, of 700,000 cu. ft. of wet gas and 54 bbl. of high gravity oil, of 46° A.P.I. are reported. The pay is a cavernous limestone of Upper Oligocene age. Further drilling is underway which may eventually prove a commercial field. El Dificil 2, located some two kilometers northwest of the first test was spudded on the 17th of July, just one year after the first test.

Upon returning from a visit to the wildcat operations in the Magdalena department the Minister of Petroleum made a public statement of his impressions as follows:

"The outlook for oil developments in this part of the country is excellent and the entire department of Magdalena is feeling the benefits from the investments being made in roads under construction. My general impression is that the country has an immediate possibility of proving a very rich source of oil. The fact that three different oil enterprises are working in the department in various locations, offers much promise. The El Dificil discovery of the Shell is most promising. The oil enterprises are making heavy investments and all indications point out to a progressive era which has just started. Large tracts are being converted into agricultural and cattle raising land, not only by local farmers but by the operators which is particularly significant because it is land hertofore unexploited.

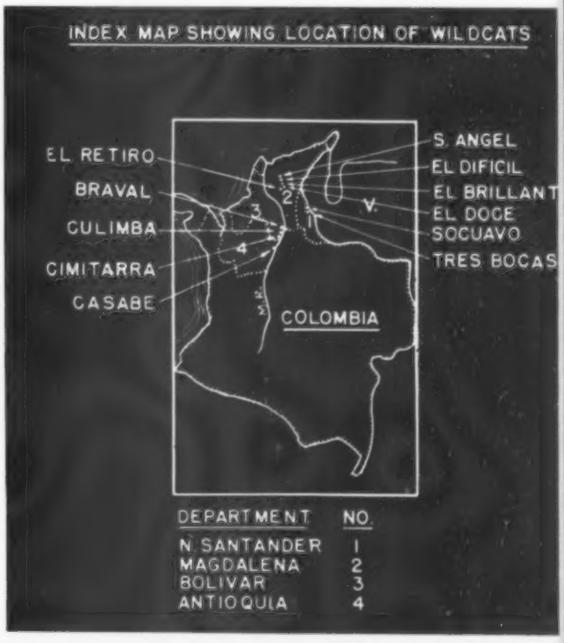
"The general health conditions of the region have contributed decisively in promoting the development and progress of the department. The oil enterprises are carrying out also a program of social protection which fulfills all the hopes of the government. Excellent temporary camps have been established in various locations, free medical service and drugs are given to the workers and to the local farmers. Tropical diseases, particularly malaria, are unknown in these regions, which are being linked gradually to the national economy. According to company data, not a single case of malaria has been witnessed among the workers of the Magdalena department.

"The oil enterprises are carrying out a very meritorious cultural and influential program among the inhabitants of the region through the movies which are shown on Tuesdays. Some of the spectators come great distances to attend these performances, which are, of course, a thrilling experience. Camp hygiene conditions are highly satisfactory. In this connection more than 1000 tons of pipe were used for an aqueduct system to bring potable water to the various camps."

The Minister added that his visit had coincided with a general wage increase granted by Shell and other operators, "which was most joyfully received, not only by the workers, but also by the local merchants and farmers who sell supplies to the company and personnel."

Magdalena department today is the object of numerous concession applications as reported officially and revealed in the accompanying map showing the geological features of this region as well as the location of present wildcat activities and the El Dificil discovery well. Only four of the tracts shown on the map are under contract, these are Nos. 81, 96 (El Dificil), 74 and 65, where wildcatting is underway. The balance of the areas are pending applications, some of which may take several years before granted in concession. Unlike the situation in the United States, where practically all the oil exploited is obtained from private property, in Colombia there is a variable ownership of the petroleum subsoil rights. These may belong either to the nation or to the private surface owner, depending on the title to the land which the latter may exhibit. This situation which often creates uncertainty regarding the validity of a title is the cause of extended delay in contracting or wildcatting on prospective oil land. In a recent bill submitted by the Minister of Petroleum, a questionable solution is proposed which would permit wildcatting freely in the country on alleged private oil land. If oil is discovered, title to the latter is then decided upon by the Supreme Court. Apparently the uncertainty of finding oil, coupled to the precarious title situation that might arise in case of a discovery, would tend to discourage wildcatting on assertedly private oil land which is contrary to the spirit of this oil bill.

Tract No. 98 shown on the accompanying map, for instance, was solicited and the concession bid subsequently accepted by the Ministry on April 9, 1940, but it covered in part land alleged to be of private ownership. An action to exclude this area from the grant was filed by the surface owner and passed upon by the Supreme Court in a tentative decision, handed down recently, or just three years afterwards. This tentative



decision becomes firm within two years, if during this period an action is not filed to contest it. In practically all cases adverse to the nation, the corresponding suit is filed. The result is a further delay of some four or more years to obtain a firm sentence, under existing provisions of the oil law. These are some of the legal obstacles and risks which an operator must contend with in Colombia, in addition to the natural and technical difficulties of wildcatting.

As may be noted, the geographical location of the Magdalena prospective oil land with respect to the Caribbean seaboard gives such oil as may be found an exceptional economic and military strategic value. The location of the Shell discovery well and other wildcats drilling and drilled during the past year, listed in Table II, are indicated on the index map reproduced herewith.

Shell is drilling directly or under contract El Dificil 2, San Angel 1, El Brillante 1. Likewise it has drilled the Casabe wells and El Doce 1, listed in Table II. The latter well reached the Sierra Nevada granite basement at the depth indicated and was abandoned. In the Casabe field, wells Nos. 5 to 10 have been drilled since last year's report. Although No. 11 is planned, the immediate program calls for testing the various pay formations. In the Casabe field, three pay zones, similar to those of the Infantas and La Cira fields of the De Mares concession, have been encountered.

Casabe wells brought in to date have been tested only partially, initial yields ranging from 200 to 1200 B/D of 21° A.P.I. oil. It is reported that Casabe 9, for instance, has a pay formation of some 3000 ft. which is to be tested. As may be seen from the data of Table II, this pay represents half of the well depth.

Since the Casabe field is close to the Magdalena river and lies below its water level, considerable earthwork and filling has been carried out and a dike is under construction along the river's edge. A modern camp with comfortable and hygienic quarters for workmen and staff is being laid out at Carmelitas, the upland part of the tract. A brick plant recently installed is furnishing the construction material for well built and solid housing.

Just north of the Casabe field, Socony is drilling under contract the Cimitarra wells. Cimitarra 2 is testing just above the 5000 ft. level. Preliminary drill stem tests reveal the presence of a 19° A.P.I. oil. It is understood, however, that the pay formation is around 1000 ft. in thickness, the most promising part of which has not been tested as yet. Cimitarra 3 located west of No. 2 has the derrick built and it is expected to spud early in September. During the year the Ministry accepted partial surrender of this tract, the concession area being reduced from 32,880 to 19,271 hectares, the surrendered area being underlain with basement rock. It is of interest to note that the law permits surrender of blocks which must conform to a polygon, whose maximum ratio, of length to the mean width, is fixed at 2.5:1. The law, however, does not state that the remaining area under contract must conform to this 2.5:1 polygon ratio, although the original concession application and grant must conform to this ratio. A recent Supreme Court decision, following this partial surrender, interprets the oil law to the effect that drilling must be carried out with negative results, in order to show that oil does not exist in commercial quantities, before such areas may be surrendered. In the case under consideration the surrendered block was underlain with basement rock, the sterility of which can be shown solely with geological and geophysical studies. The anomalous situation created by the Supreme Court decision may be corrected through a bill recently submitted to Congress calling for a modification of the oil law.

Further north of the Cimitarra test, Richmond Petroleum Co. (Standard Oil Co. of California) explored the Villamizar and Camacho tracts. In addition to the wells listed in Table II, a great number of structural holes were drilled for subsurface correlation, making use of Schlumberger logs, micropaleontology and heavy mineral analyses. The tests listed in Table II reached the Cretaceous at the depths indicated. In the Camacho concession a geophysical crew worked the northern part of the tract recently. Richmond is represented in the Magdalena department where it has concessions, pending applications and lease of private oil lands. On May 1 Richmond spudded its first test in this area, El Retiro 1, located at the common corner of the three concessions, Nos. 74, 65 and 79, as shown on the map. Although some surface and geophysical exploratory work was carried out in the Llanos during the latter part of last year, Richmond has directed its exploratory activities to the Caribbean coastal area. Some gas showings have been reported at El Retiro 1; drilling and coring continues and it is equipped with a heavy rig which will make possible a 10,000 ft. test if necessary.

In the Barco concession (Texas-Socony) wildcatting continued in the Socuavo-Tres Bocas area. Findings during the past year are encouraging, giving promise of development of one of the large oil fields of the country. The Socuavo structure has two pay formations, a Tertiary limestone at 4000-5000 ft. level and a Cretaceous limestone at the 9000-10,000 ft. level. A high gas yield was obtained from the lower pay and it is reported that preliminary tests of this formation gave from 500 to 1700 bbl. per day of high gravity oil, 56° A.P.I. Tres Bocas test area, which is part of the Socuavó structure, lies about 14 miles from the Socuavó tests, indicating the size of the field in development.

The Texas Company has carried on considerable

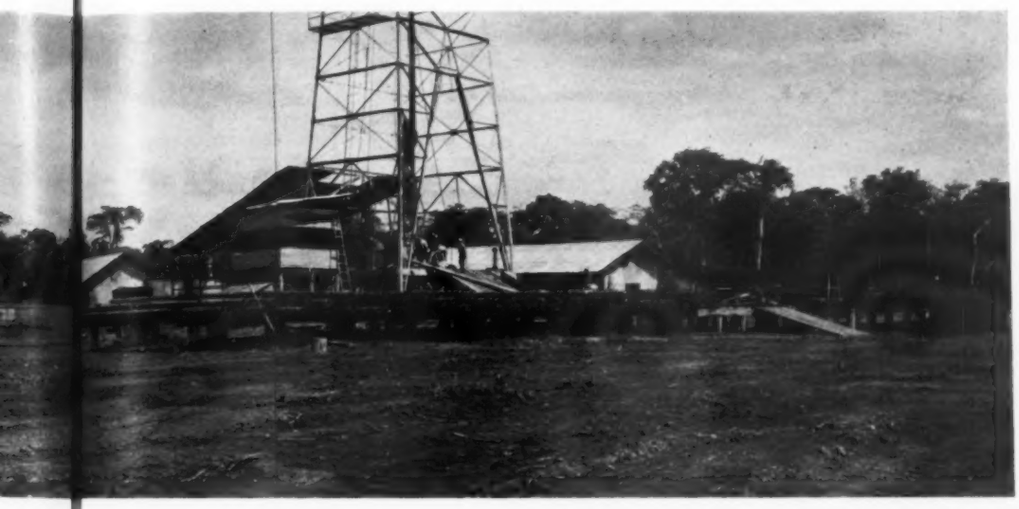
TABLE I.

List of Concessions Applied For and Under Contract in the Department of Magdalena Shown on Map (Areas in Hectares-Acres Multiply by 2.471)

No. Shown On Map	Operator	Date Contracted	Area-Hectares
65	Richmond Petroleum Co.	Nov. 28, 1940	18,515
74	Cia. de Petróleos Shell	Nov. 29, 1940	47,784
96	Cia. de Petróleos La Estrella	Nov. 29, 1940	48,568
81	Cia. de Petróleos La Perla	Nov. 26, 1940	49,985

Order of Filing	Applicant	Date Accepted by Ministry	Area Solicited
79	Cia. Petrolera de Bogotá	Dec. 7, 1939	47,553
98	Jaime Samper	Apr. 9, 1940	43,500
107	Cia. Colombiana de Petróleo El Dorado	Nov. 26, 1941	49,996
110	Cia. de Petróleo Gran Colombia	Aug. 20, 1941	50,000
115	Contratistas de Petróleos	June 19, 1942	49,812
117	Tolima Land Company	June 19, 1942	50,000
121	Camilo Gutierrez	Sept. 1, 1942	49,000
122	Pedro Ignacio Escobar	Dec. 9, 1942	49,194
124	Mauricio Restrepo	Mar. 18, 1943	49,998
125	Gonzalo Mejia	Jan. 25, 1943	49,000
128	James A. Tong	May 10, 1943	47,852
129	Exploraciones de Petróleos	June 17, 1943	49,758
130	Jesus Echeverri Duque	May 7, 1943	44,210
133	Carlos E. Rodriguez	May 5, 1943	35,840

surface and geophysical work in the Llanos and along the Caribbean coast; various concession applications in these areas have been filed. In the vicinity of Florencia, the headwaters of the Putumayo river, Colombia's southern international boundary, oil concession applications have been filed. Texas is also identified with concession applications further north in the Llanos. A wildcat program scheduled to be carried out on some of its properties owned in fee, has been held up by restrictions imposed on inland wildcatting and other difficulties which may prevail for the duration. Recently Texas moved its radio exploratory equipment from the Llanos and obtained a permit to operate it in the Caribbean coastal area, which is the exploratory direction all the majors are taking now.



Rigging up well preparatory to drilling at El Dificil.

Tropical Oil Co., which operates the De Mares concession, presented surrender of the Gutierrez tract, just north of and adjacent to the Yondó (Casabe) block of the Shell, after two unsuccessful tests which reached 4171 and 9502 ft. respectively. The Ministry delayed acceptance, alleging that the technical findings had not shown satisfactorily the non-existence of oil in commercial quantities. After presentation of additional technical data, the Ministry, on June 10 last, accepted full and complete surrender of the concession. At the same time it authorized Tropical to remove all of its drilling equipment and other property from the tract and to obtain return of the bond guarantee deposit.

According to a Supreme Court decision the right of surrender, granted in article 24 of the oil law, is subject to a condition of not finding oil in commercial quantities. The Court holds that this cannot be arrived solely through geological and geophysical studies but must include drilling. The operator assumes the obligation, under the concession contract, of a negative proof; namely, to show that oil does not exist in commercial quantities. The Court, however, does not define the latter.

Tropical carried out surface work and gravimetric investigations in the Llanos and filed its first concession bid, covering 97,046 hectares (239,400 acres) in this prospective oil region in the Department of Boyacá. The decision of Tropical is most significant because it represents the fourth major operator to solicit oil lands in concession in the Llanos. The latter region constitutes 50 percent of the total prospective oil land of Colombia, lying some 750 or more miles from tidewater. A pipeline from the Llanos may find an outlet directly overland with an export terminal either on the Pacific or Caribbean seaboard. As an alternative, such pipeline might extend to a terminal on the Orinoco or Amazon rivers or their tributaries. The overland route calls for the scaling of the Andes at elevations of not less than 8000-9000 ft. above sea level, whereas via the Orinoco or Amazon rivers the technical and economic problems may not be as great.

A pipeline to tap the Llanos and bring its oil to tidewater calls for a development and transportation capital investment of great magnitude, which may be justified only if a large volume of oil is discovered, estimated at a minimum of six hundred million to one billion barrels of oil, which must be exploited within the 30 year period granted in a concession contract. This in turn means the discovery of a number of major oil fields. Wallace Pratt, in his admirable little book, "Oil in the Earth" defines a major field as one whose ultimate production will exceed 20 million barrels of oil and adds that during the twenty year period, 1920-1940, such fields account for more than 80 percent of the total oil discovered in the United States. The attendant risk in finding one billion barrels of oil, the volume sought in the Llanos, may be appreciated from the data Pogue cites in the A.I.M.E. volume, "Elements of the Petroleum Industry." According to Pogue's study, during the entire life of the American petroleum industry, a dry hole has accompanied the discovery of 179,000 bbl. of oil and he indicates at the same time that with the discovery of one billion barrels of oil may involve some 4000 dry holes.

In the bill recently submitted to Congress the Minister of Petroleum asks that the government royalty participation be increased. The present schedule calls for a royalty participation of 11 to 2 percent, appraised at the maritime port of shipment. The proposed schedule ranges from 13 to 3 percent, which represents an increase of 18.2 to 50 percent over the schedule in force. In addition, the Minister asks that the annual

TABLE II.

Continuation of List Published in World Petroleum September, 1940, 1941

Operator	Location: Department	Location: Filing No.	Location: Concession	Well	Maximum Depth Reached —Feet	Results or Status	A.P.I. Gravity
1. Compañía Colombiana de Petróleo El Condor	Antioquia	26	Yondó	Casabe 5	3630	Producer	21.2°
				Casabe 6	4002	Producer	21.2°
				Casabe 7	3608	Producer	21.2°
				Casabe 8	3750	Producer	21.2°
				Casabe 9	6086	Producer	24°
				Casabe 10	7321	Fishing job	
				Casabe 11	....	Locating	
2. Compañía de Petróleo Shell de Colombia	Magdalena	74	El Doce	El Doce 1	10,046	Abandoned	
				El Brillante 1	8270	Drilling	
3. Compañía de Petróleo La Estrella de Colombia	Magdalena	96	El Dificil	El Dificil 1	5950	Producer	46°
				El Difícil 2	....	Just spudded	
4. Compañía de Petróleo La Perla de Colombia	Magdalena	81	San Angel	San Angel 1	2960	Drilling	
5. Compañía de Petróleos del Valle del Magdalena	Antioquia Bolivar	41	Cimitarra	Cimitarra 2	6170	Testing	19°
				Cimitarra 3	....	Rigging up	
6. Richmond Petroleum Co. of Colombia	Magdalena	65	Granger	El Retiro 1	2750	Drilling	
7. Compañía de Petróleo Occidental	Bolivar	80	Villamizar	Culimba 2	4273	Abandoned	
8. Compañía de Petróleo Sierra Nevada	Bolivar	54	Camacho	Braval 3	923	Abandoned	
				Braval 4	881	Abandoned	
				Braval 5	815	Abandoned	
9. Colombian Petroleum Co.	N. Santander		Barco	Socuavo 3	5245	Producer	37.4°
				Socuavo 4	51313	Producer	33.1°
				Socuavo 5	635	Drilling	
				Socuavo 6	....	Building road	
				Tres Bocas 3	5070	Producer	22.5°
				Tres Bocas 4	....	Building road	

Note: Concession numbers refer to order of filing under provisions of oil laws 37 of 1931 and 160 of 1936 and appear on map for identification. To date 166 oil concession applications have been filed.

Socuavo No. 1 in the Barco concession.

exploratory surface fee be converted into a tax, increased, and levied during the exploitation period. This tax would be imposed on the area held in concession and similar to the capital assets levy in force at present. It would be payable irrespective of the amount of oil exploited. In view of the economic problems which Pratt's and Pogue's statements point to, in realizing the commercial development of the prospective oil land in the Llanos, obviously the economic burdens established in the oil and tax laws and those added through new legislation, may be the decisive factors in postponing, if not, in eliminating the development of half of Colombia's prospective oil land.

Although the progress of the war has not reduced wildcatting drastically in comparison to last year, prospecting activities undoubtedly would have been more intense except for war conditions. A far more encouraging overall picture is given by the accompanying table of wildcat activity than last year, which augurs an intensive development program upon cessation of hostilities. Until peace returns wildcat drilling will be governed by the availability of freight space, materials and equipment. Maritime freight space is the governing factor, Colombia having been assigned nominally a monthly quota of 9000 tons, only a small portion of which can benefit the oil industry.

Oil production has continued to drop due to the lack of tanker calls at the export terminals. During 1941 the average monthly production amounted to 2,050,000 bbl. In 1942 it dropped to 875,000 bbl., the decline being particularly sharp during the second semester of the year. For the first six months of 1943, oil production has averaged 590,000 bbl. per month, 97.5 percent of which is obtained from the De Mares and 2.5 percent from the Barco concessions. The country's domestic requirements, indicated by runs to stills, amount to 250,000 bbl. per month. The difference between current oil output and the domestic consumption represents shipments through the export terminals, made possible by a few tanker calls. The expectation is that steps will be taken very shortly to allot more tanker tonnage for the movement of oil from Colombia. This measure is significant not only to the oil industry, but also in bringing much needed revenue to the national and departmental treasuries through royalty payments.

Although oil production has dropped, an unusual activity has been displayed recently in applying for oil concessions. As of June last year the Ministry reported 120 oil concession applications filed, whereas at this writing, August 1, 1943, the number has jumped to 166, revealing 46 concession applications during this period. Since the average area solicited is close to the 50,000 hectare maximum allowed, the total additional area earmarked for future exploration is in the neighborhood of 2,300,000 hectares (5,700,000 acres). For the Magdalena department this activity may be appreciated from the map and concession applications listed in Table I.

During the past year and as a consequence of the world conflict, Colombia has experienced a most anomalous national economic situation which has brought about a number of fiscal measures, the principal aim of which has been to cover the anticipated deficit in government revenues and to offset a potential inflationary movement due to the abundance of cash and the lack of purchasable goods. Although still in the incipient exploratory stage and with oil exports practically at a standstill, the oil industry, as an integral part of the national economy, of course has not escaped the application nor effects of these measures. Dr. Esteban Jaramillo, noted economist and general manager of the oil royalty enterprise "Regalías Petrolíferas Colombianas" in a public statement outlines Colombia's economic plight, which he characterizes as follows: (1) High export values, low import indices (2) Enormous dollar reserves and deposits in the central bank of issue and commercial banks (3) High prices for securities (4) Exorbitant prices for consumer goods and raw materials (5) Difficulties for manufacturing industries due to lack of necessary materials (6) A constant drop of fiscal revenues due to import restrictions and loss of customs revenues. Dr. Jaramillo, sees the situation as a fiscal crisis which may be summed up as, "an impoverished government treasury amidst an abundance of available cash."

In view of the situation outlined by Dr. Jaramillo, Congress approved the government "fiscal plan" the object of which is to obtain some of this available cash and in part freeze its circulation for the purpose of offsetting the inflationary movement. Income taxes were increased 85 percent; 50 percent of this payment is reimbursed with 6 percent interest bearing bonds, due in 30 years; 35 percent of the payment will remain in force until the bond issue is redeemed. The latter is authorized up to 60 million pesos, equal to 75 percent of the total yearly government budget of income and expenditures. Through an obligatory subscription to these bonds, 20 percent of incoming capital funds are "sterilized," including incoming oil exploration funds. Although purchased at par, the bonds sell at a discount and are currently quoted at 93. Another recent measure obliges all enterprises to subscribe 20 percent of the net profits in "sterilization certificates," due in two years; also 50 percent of the amount carried on the books for depreciation.

The country's highest tax court in a recent decision holds that development expenses carried on the books, to be amortized through depletion, constitute taxable capital assets. In this connection it is of interest to note that for income tax purposes a depletion allowance ranging from 1¼ to 5 percent of the net income is the maximum allowed. This means that amortization through depletion is practically eliminated and due consideration is not given to the high intangible development costs in Colombia. Although the increased royalty and newly proposed surface taxes asked for in the bill before Congress may be held equitable under special circumstances, obviously due consideration should be given to the fiscal measures and taxes originating with the Ministry of Finance.

Below: Panoramic view of "Petrolea" main camp of Barco concession.

Bottom: Preliminary plane table survey for gravity meter station location.

SUPERFRACTIONATION'S PLACE IN REFINING

A TERM which has lately attained much currency in petroleum refining is "superfractionation". It refers to a refinement on the art of distillation, where the object is to separate a complex mixture of liquid substances that have different boiling points.

The object of early petroleum refining was to remove by batch distillation a series of "cuts", each one of which met a number of somewhat liberal specifications. Later, this procedure was gradually replaced by continuous distillation in which the fractionation of the product was carried out in a more exacting manner. Improvements in the procedure continued to be applied through the past 20 years of modern petroleum refining.

In the more recent years and with the coming of petroleum chemistry, the application of good fractionation has become doubly important. These new chemical processes operate much more effectively if in each case the raw material they work on is a single hydrocarbon, or a simple mixture of hydrocarbons. It is also sometimes necessary to fractionate the final product of such chemical syntheses to produce finished or partly finished products of very narrow boiling range. The more recent processes calling for high quality materials produced by careful fractionation include catalytic cracking, isomerization, cyclization, polymerization, alkylation and dehydrogenation, among many others. All of these processes have as their object the production of materials of controlled molecular structure. As a consequence, closely controlled raw materials are a basic requirement in each instance. For example, the new and extremely important synthetic rubber industry requires butadiene of around 99% purity; the manufacture of trinitrotalune (TNT) requires toluene that is practically pure. Without equipment for superfractionation it would be difficult and costly to meet such specifications.

Many petroleum companies early foresaw the need for perfecting fractionation so that this process could be used for the preparation of better starting materials in the complex processes of hydrocarbon synthesis. This can be explained, possibly, by the early prominence given the analyzing, separating and utilizing (for commercial application) the very low-boiling fractions originally included in natural gasoline. Natural gasoline contains numerous light hydrocarbons which formerly were prized mostly for their volatility and higher octane ratings in automobile fuel. To separate the components required for such use was at that time relatively easy. Later, when World War II created an enormous demand for 100 octane aviation gasoline, natural gasoline acquired enormous importance as a source of isobutane and butane, out of which iso-octane is made. It was chiefly the need for separating these invaluable hydrocarbons that prompted efforts to make superfractionation commercially workable in the oil refining industry.

Generally, the object is to separate propane, butanes, pentanes and other hydrocarbons from natural (straight run) and refinery gasoline. The charge enters a tower or series of towers as a single stream; the function of these towers is to split this stream into as many useful "cuts" as the original charge may contain.

A typical, closely fractionated hydrocarbon produced by such an installation shows the following characteristics (data supplied by Phillips Petroleum Company):

Gravity	81.0° API
IBP	123.5° F
10%	129.0° F
50%	133.8° F
90%	138.8° F
DP	141.8° F

Products of still narrower boiling range have also been prepared for specific application. One such product possessed the following characteristics:

Gravity	75.2° API
IBP	151.2° F
10%	153.1° F
50%	153.7° F
90%	154.6° F
DP	155.3° F

In this case the range between the initial boiling point and the end point is only 4.5°, indicating a remarkably close separation; even this has been improved upon.

In most installations designed for this work bubble towers are used which contain a relatively large number of trays one above the other. The towers are designed to operate under much higher than average reflux ratios. One commercial installation now in routine service utilizes 80 plates and operates with a reflux ratio of 25 to 1.

Some of these superfractionating towers are as tall as an average 15-story building. After being fabricated on the ground their erection calls for unusual engineering arrangements. The fine installation shown on the front cover of this number of WORLD PETROLEUM is a fractionating unit at one of the Phillips Company's plants in Texas.

Towers containing 40 trays each have been used as standard, and three such towers connected in series have been employed on occasion to produce the effect of 120 trays. For experimental purposes such units have been operated with reflux ratios as high as 100 to 1. Such extremes in operating conditions are not common but are mentioned to show the great flexibility inherent in the fractionation process.

It is of course known that close fractionation is an essential process step in many other industries, notably the alcohol and the by-product coke industries. In these other industry applications the range between the initial boiling point and the dry point of the final product might be appreciably less than that shown for the finished products of petroleum distillation.

Within recent times the work of the superfractionation towers has been supplemented by two other means. One of these is azeotropic distillation, which the oil industry has borrowed from the industrial alcohol industry. It depends on adding to the charge of mixed hydrocarbons a foreign liquid which will alter the volatility of a desired hydrocarbon, so that it will leave its associated hydrocarbons that have boiling points so close together that they cannot be separated by straight distillation alone. This principle of azeotropism is especially useful in the preparation of pure hydrocarbons for the chemical industries. Another principle which helps out in fractionation is selective solubility, which is an extension of an art used in purifying or refining high grade lubricating oils by dissolving out undesirable substances.

Superfractionation section of a Texas Refinery.

SOME ASPECTS OF UNIT OPERATION OF OIL FIELDS

Unitized Management of Oil Fields Essential to Prevent Waste and Insure Maximum Recovery—Laws Should Give Specific Authorization to Voluntary Agreements

By Leslie Moses
Secretary and Counsel, Fohs Oil Company, Houston, Texas

UNIT operation is a timely topic. It lends itself to profitable discussion because it is not so novel that we are without pertinent facts, and yet not so trite that we do not need more. It invites objections, yet opens up a vista of new methods of solving old problems. It relates strongly to current economic thought and is an elaboration of the "cooperation-conservation" movement. It is also an extension of the partnership idea. From a legal and leasing standpoint it is sound and practical, and its growth should be fostered. Its expansion into common practice is dependent only upon the mechanics of contracts and accounting procedures becoming more or less standardized, and upon the elimination of certain controversial questions hereinafter discussed.

It is the only known method of relating recoveries to the equities of ownership. In other words, complete unitization of the pool (as the term is hereinafter defined) is the only way whereby the various individual owners in a pool can recover from the common source of supply their share of the recoveries from that reservoir proportionately to their interests therein.

In the background of unit operation is the law of oil and gas itself. Law is of value to society only in the results it produces. As society and its needs change and grow, so, inevitably, must the law change and grow. The last decade has witnessed many changes in various branches of the law, not the least affected being the law of oil and gas. Despite its growth, however, it is still in the same fluid stage as the subject matter with which it deals. The oil industry has been struggling with legal problems arising out of laws that are a heritage from the early period of the infancy. The early ignorance of the true nature of oil has yielded to the knowledge that though a prisoner of nature, it is not a vagrant. So, too, have the courts developed more advanced concepts of legal rights, yet the process of development has been slow. In the early days strange analogies were drawn between oil and gas, on the one hand, and other natural occurrences on the other, which comparisons led to the establishment of the Rule of Capture and the Offset Drilling Rule. These rules have been discussed many a time, and it is sufficient to say that they sanctioned and encouraged hasty development, disorderly operations and immeasurable waste. They forced operators to protect themselves by hastening the depletion of their own holdings. It has been a destructive self-preservation.

The major objectives of the oil industry should be the efficient withdrawal of oil and gas and their equitable distribution among owners.

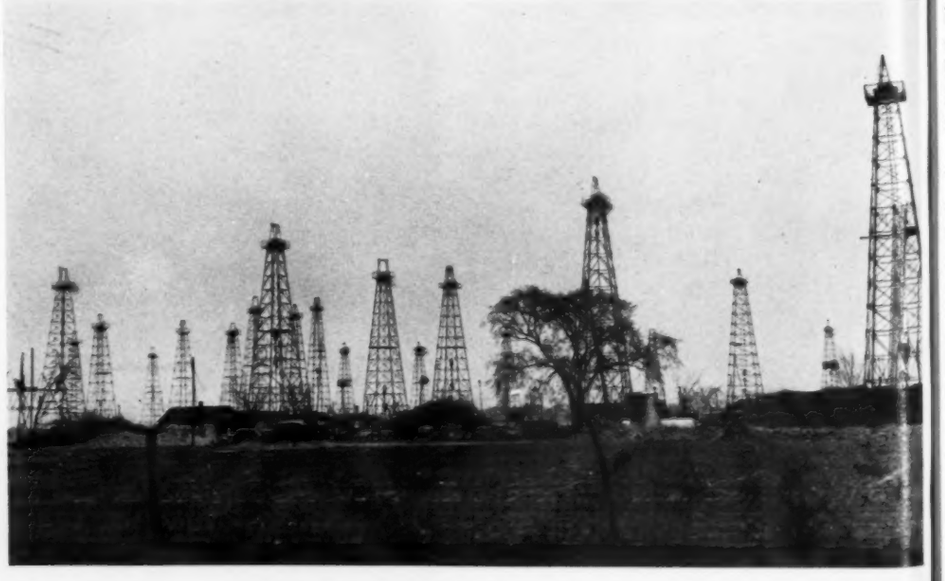
These were impossible under such rules. The adoption of a better rule is in order. It takes time, study and a program of education. Education, while slow, is vital. The first step has been the enactment of conservation legislation. The oil industry and the states have accepted the idea that conservation and sound business practice (economics) demand the efficient spacing of wells and the scientific control of production. The fact that rights in oil and gas leases are subject to regulations and limitations by the police power of the state, the same as ordinary property rights, has been accepted as a matter of course. In the development of proration we have witnessed the exercise of police power in the control of actual production as an outgrowth of self-regulation in the industry. What is needed now is the control of potential production, the prevention of the unnecessary well, or at least regulations which will not require unnecessary drilling. This likewise can be achieved by self-regulation within the industry. The obvious approach is education of all concerned. The real need today is for the promotion or sale of the idea of unit operation, with the admitted aim of making land and royalty owners, operators and lawyers "unit conscious", and to so plan and administer unit operation as to make it equitable to all parties in interest. Much has already been written concerning the value of unit operation, and many of the arguments are sound. The difficulty lies in bringing it into actual practice.

In any discussion of unit operations, certain terms must be used, and for the purpose of this discussion the terms will have the following meaning, even though the definitions may not conform in all respects to the generally accepted usage thereof.

A "joint venture" is an undertaking between two or more persons for a specific purpose or single enterprise. In nearly every instance there is involved the element of confidential relationship between the parties, which often overshadows all other considerations. While it has some of the characteristics of a partnership it is not to be considered as one. The two relationships are not identical.

One should exercise extreme care in the use of words "pooling", "unitization" and "unit operations", and should avoid speaking of "unitization" and "unit operations" when dealing with uniform spacing drilling units and the like. There has been a fairly consistent effort in the past few years to refer to "pooling" as denoting that species of joint ventures which is brought about to obtain uniform spacing, or in connection with drilling or proration units. Where the size or shape of an individual tract does not conform to that of a standard proration unit "pooling" of properties is to be considered. It gives each operator his fair share of the allowable production without being required to drill unnecessary wells to obtain it. It is much more frequent and common than "unit operations". More and more instances are found where small tract owners pool their interest to form a drill site, sharing in the ex-

Indiscriminate drilling resulting in unnecessary wells and waste of underground resources.



This article is a condensation of a more extensive discussion of the subject appearing in the Texas Law Review, Vol. 21, June 1943.

penses and the recovery proportionately. Some states have adopted compulsory pooling statutes and the validity of such statutes has been upheld by the courts.

On the other hand "unit operations" or "unitization" connotes, more or less, a joint venture on a grand scale, covering an entire pool. It is the practice of consolidating or integrating the ownership or control of an actual or prospective oil or gas pool or area by combining all titles or interests so that it may be explored, developed and operated as one property for the benefit of all parties concerned. There are two bases of establishing unit operations:

(a) The merger of all interests, titles to leases, royalties and minerals.

(b) The merger of the operative and working interests only, leaving titles to royalties and minerals in their respective owners.

The essential is in the legal relationship of the royalty and mineral interests to the operating interests, and the mechanics of distribution of payment. "Unit operation" is simply operation of a unit. The term needs no more elaborate definition. A point too little stressed in any discussion is its fundamental simplicity. It is a multiple partnership. There is no principle involved that is not usual to a normal partnership in a lease development program; there is no singular particular that transcends any of the legal sanctions of common or statutory law, as applied to partnership; there are no prerogatives granted that are not usually granted between partners in lease operations; there are no terms used that contradict the lease forms in generally accepted use.

There is another example of joint venture called "Cooperative Development and Operation". Here neither the ownership nor the management is single, in a unit, but unity of operation has been attained by mutual agreement. Unlike unit operations or pooling, this type of joint venture does not contemplate the unification of ownership of separate tracts, but on the contrary, the retention of individual titles and the development of each tract by its individual owner in accordance with a preconceived and preagreed plan, adopted by all operators in the pool. It has its advantages in that the owner of the tract drills, produces and operates his own wells. No one but himself has any interest therein, although their spacing and rate of production are governed by the cooperative agreement. The Yates Pool, in Pecos County, Texas, is a notable example of this type of development.

"Secondary Recovery Operations", of necessity, are joint ventures. Primarily the term relates to operations conducted in pools depleted by ordinary production methods. This is important to bear in mind. It is recognized generally as being that recovery which may be obtained by the injection of liquids or gases into the reservoir for the purpose of augmenting the reservoir energy. Such operations are closely allied to unit operations.

Unit operation with wells evenly spaced prolongs life of field and avoids waste.

As a general rule they are carried on where an entire reservoir or large part thereof is involved. This is necessary for such operations to be in any way effective and practical. Land and lease lines must be ignored to a great extent. It is important that the consent and agreement of all parties be secured. In most instances unit operation agreements or some similar methods are essential.

In discussing "pooling", "unit operations", "cooperative development" and "secondary recovery" there has been repeated the term "joint venture". It is quite evident that such words denote "cooperation" which is the essential characteristic of unit operation. It is cooperative action as contrasted with individual action. Unit operations propose to substitute cooperation for competition. Unrestrained competition has proved to be inequitable and often uneconomical. With the establishment of more efficient and more stable practices and uniform accounting methods, cooperation becomes logical and practical.

The advantages to be derived from unit operation are so great that it seems inconceivable that more pools in the United States are not unitized and so operated. Obviously, one operator controlling the entire pool has no incentive to drill more than the number of wells actually needed to bring the recoverable oil to the surface, nor has he any desire to increase the cost of production by unnecessary duplication of equipment and effort. Yet in the past when a number of operators have developed a pool under the competitive method, there has been a strong tendency on the part of some to attempt to get out of the ground as much as they could, and usually with little regard for cost, efficiency of recovery or the right of others. Economic considerations, based upon the waste resulting from such competitive methods, were entirely responsible for the trend toward the abandonment of close drilling as practiced in the early days of the industry, and for the adoption of more or less uniform rules and regulations relative to offset drilling. By the same token, economic pressure inevitably will bring about more widespread pooling and unitizing to provide for even wider spacing of wells.

In examining the history of the oil industry we can now see that there are definite periods, constituting eras, in the march of the industry toward sound conservation. In the beginning operators drilled wells as they saw fit, in most instances too closely. This having been tried and found wanting, it was determined that economic preservation depended upon drilling at greater distances. Uniform spacing of offset wells came into practice. Industrial evolution during the past two decades has shown a clear trend toward economic cooperation. The oil industry has evidenced this trend in the cooperative efforts that have resulted in the orderly restriction of production. Each of these has added its quota of results to the stabilization of the industry, to the true cause of conservation and to the elimination of waste in efforts and resources. Unit operation can and will do more than all these other efforts to effect conservation and prevent waste, physical and economic. The time has come for the lessons of experience to be reduced from informal precedents into a group of well-defined obligations and principles upon which the future may be built.

There are but two basic types of unit operation, voluntary and compulsory. Most students of the problem are in agreement that the operator, the royalty owner and the general public would each

and all be benefited greatly if the individual pools were operated as units. Regardless of the fact that unit operation is neecssary and advisable, limited progress has been made in the field of voluntary unitization. General adoption of the practice in the United States has been delayed because information as to its advantages has been lacking and satisfactory means have not been developed to bring about consolidation of interests. Where it has been impossible to prove to an operator or royalty owner that his condition would be greatly improved by joining with others, individual operations in that particular pool would play havoc with the voluntary agreement. Per se it would prove a source of trouble because of the non-cooperating operator's power to produce to the detriment of the unitized area. Further it would make hazardous continued operation under voluntary agreement. So unless unanimous consent is obtained the present system of land titles and lease makes voluntary operations difficult.

Unanimous agreement on details of unitization by parties entitled to drill in a common pool has been so difficult to procure, and unanimous action is so desirable in unit operations, that advocates of legislation to compel unit operation have not been lacking. However, taking one property from an individual and arbitrarily substituting another, or part in a larger piece, without his consent, is a procedure difficult to conceive under our law, even though it is obvious that such consolidation would be in the public interest and is being done at the request of the majority in the pool. This is true notwithstanding it may be apparent that the one who refuses to cooperate is prompted partly by the hope of extracting more of the contents of the pool than underlie his land.

In discussing unit operation, one cannot overlook the fear of possible prosecution on alleged violations of anti-trust laws. This fear is not limited to compulsory unit operation, but applies equally as well, if not more so, to voluntary unit operation. It is recognized that unit operations are designed to increase ultimate recovery from oil pools, and do away with unnecessary drilling as well as the duplication of other facilities. Nevertheless the agreement or operations conducted thereunder may result in a restriction of production, which, although absolutely necessary to prevent waste, may be asserted to be a possible violation of the anti-trust statutes, such as are in effect in states like Arkansas and Texas. There is always the fear in such states, whether well-founded or not, that either the state or the federal government will bring an anti-trust suit against the operators, claiming the agreement is but a scheme to control and regulate production from the pool. Landowners and operators have used such possible fear as an excuse for not entering into voluntary agreements, thereby maintaining what they consider an advantage over others. Since each particular agreement presents a different set of facts, there can be no ready answer to the complaint that is given unless proper legislation is enacted by the states and the federal government protecting signators to such agreements. A new law by Congress, more fully stating principles, is long overdue. To be in any way effective such laws should (1) authorize the execution of unit operation agreements and (2) construe their execution as not being violative of any statutes of that state relating to trusts, monopolies or combinations in restraint of trade. To a limited degree some such statues have already been enacted in a few states, notably Arkansas and Mississippi.

Unit operation by compulsion, that is, under a valid and subsisting state statute, has its drawbacks. The validity of any order issued must depend upon the reasonable necessity for the same to prevent waste and protect correlative rights. Robert E. Hardwicke, well-known Fort Worth oil attorney, has pointed out that the courts will be reluctant to uphold as reasonable such drastic control of property if it be proved that substantially the same results would be obtained by similar practices not bearing so heavily upon property rights and the exercise of discretion. For example, waste can be prevented by closing in production, yet that method is too drastic, unnecessary and unwarranted. Reasonable methods can bring about the same results, so the courts would rightly disapprove a cessation order.

There are other complications arising from compulsory unitization, some of which appear to be insurmountable. Unless the unit is formed early in the life of the pool, the prime advantages, such as elimination of unnecessary wells and the most efficient use of reservoir energy, are partially or entirely lost. There would remain only the advantage of secondary recovery. On the other hand, until a pool has been developed to the degree where sub-surface conditions are sufficiently well known to justify an appraisal of relative property values over a considerable area of the pool, a regulatory body would be open to attack for issuing a compulsory unit operation order. If, however, such an order were issued, it would probably allow for expansion and would certainly have to provide for a certain amount of exploratory drilling to determine the limits of the reservoir. It would further have to provide for the rearrangement of relative property values from time to time as conditions and findings warrant it.

Although great progress has been made from time to time in the art of estimating reserves, it is not an exact science. Production seldom occurs in textbook fashion and almost never occurs in perfect uniformity under all leases. Lack of uniformity is not only common as between leases in the same pool, but also frequently is observed as between wells on the same lease. As evidences of these differential values appeared, a rearrangement of participation values would be indicated with resultant debits and credits. Consequently the finding of the regulatory body might easily be said to have been based upon unsubstantial evidence in the first place.

With these complications present, it is probable that the courts would strike down such an order as unreasonable and constituting unwarranted regulation of property rights. The value of unit operation in the ultimate recovery from the pool would have to be well demonstrated before the courts would hold that the extraordinary restrictions which would take place were justified as reasonable. While the merits of unit operation are indisputable, it is still unlikely that compulsion by statute is possible. Because of the obvious advantages of unit operation and because of the serious legal obstacles to statutory compulsion, voluntary unit operations are clearly indicated. The voluntary principle is entirely in harmony with our concept of property. Its general adoption will certainly follow a general understanding of its merits and modus operandi. It may also be said that compulsory unit operation is not capable of correcting any faults in our present system that cannot be corrected by voluntary agreements.

The theory being advanced here is not that unit operations are the sole remedy, the cure-all, for the evils of the rule of capture and the offset drilling rule. Unit operations in no way repeal or overrule these doctrines. It is believed, however, that by such a plan of development and operation the evils inherent in them can be dispelled and the doctrines themselves rendered ineffective. The principles of unit operations prevent unnecessary drilling, conserve reservoir energy, increase ultimate yield, stabilize the industry, and are justified in every respect. That unit operations are in the interest of the public is obvious; that they cannot be obtained until the public has been convinced of their practicability and benefit is plainly evident. The complications arising from compulsory unit operations are too great to overcome at the present time so the alternative must be voluntary agreement.

The danger is that if the industry does not aggressively undertake the furtherance of voluntary unit operations, operators who are seeking relief from burdensome conditions and are unwilling or unable to await the slower processes of constructive action, will appeal to the government for relief, and will burden the industry with legislative enactments depriving it of that freedom of action which it now enjoys.

The doctrines of the Rule of Capture and the Offset Drilling Rule breed destructive competition, which necessarily leads either to industrial monopoly or governmental control. Since industrial monopoly is not tolerable under the present state of government, the inevitable result may well be governmental control unless those doctrines are rendered ineffective. The oil industry is rapidly passing out of the stage of destructive competition. It must avoid both industrial monopoly and governmental control. It can avoid both. From the standpoint of intelligent self-interest the entire oil industry must seek means to that end.

DEMONSTRATION PLANTS PROPOSED FOR SYNTHETIC OIL

O'Mahoney Bill for Government Supported Research Into Cost and Possibilities of Shale and Coal Wins Support at Committee Hearing

DEPENDENCE on oil from coal and shale to supplement America's petroleum supplies may be a long way in the future, but now it is not too soon to prepare for production on a commercial scale. This was the burden of the testimony put on record by representatives of government and industry early in August before the Senate Western Minerals Subcommittee headed by Senator Joseph C. O'Mahoney of Wyoming. Under consideration was the Senator's bill, S. 1243, authorizing government construction and operation of demonstration plants to determine the cost and the most effective processes for obtaining oil from these sources. As explained by the Wyoming Senator it was not the purpose to have the government engage in such production, but to take the lead in further research into synthetic liquid fuels, thus paving the way for industry to enter the field when the necessity for commercial production arrives.

The Bureau of Mines has already carried on preliminary research on a laboratory scale at its pilot plant in Pittsburgh, Pa., but its capacity is too limited to serve as a commercial guide. The plants now sought under the O'Mahoney bill would enable government scientists to carry the work a long step toward ultimate commercialization.

Petroleum Administrator for War and Secretary of the Interior Harold Ickes gave full endorsement to the proposal. In discussing the bill, Mr. Ickes said, "This country can no longer delay embarking upon a synthetic fuels program. Those in my department who are authorities on petroleum are in agreement with this idea. Our continuing study of reserves and the rate of depletion indicates clearly that unless we take action the end of the gasoline age is in sight. This development—and I fix no date for it—will inevitably bring major repercussions throughout our entire economy in peace as well as in war. No man can predict accurately the vast ramifications involved in a changing economy such as would result from a cutting off of gasoline and oil, but I do say that it would be of momentous consequences, attended by confusion, deprivation, and a possible decline in world power and prestige."

Mr. Ickes said it was no secret that the country's known petroleum reserves are limited and that the time may not be far distant when they will be inadequate. For several years past, he pointed out, we have been consuming petroleum nearly three times as fast as we have been able to discover new sources. The Secretary stressed the need for immediate action on the O'Mahoney bill for "bridging the gap between the little that we know and the great deal that we must learn, and for preparing ourselves against the day when our natural petroleum reserves may be depleted."

Mr. Ickes thought we might take a lesson from Adolf Hitler in the matter of synthetic gasoline. In 1930 a large hydrogenation plant in Germany, he told the Senators, was producing 30,000,000 gallons a year, and six years later this and three other plants were turning out more than 200,000,000 gallons. The "last fairly definite" figures we had from Germany in 1939, he said, revealed that the Nazis were getting about one billion gallons of gasoline from coal and today the figure may be nearer two billions.

England, too, Mr. Ickes pointed out, has been producing gasoline from coal since 1935 and her plants have provided millions of gallons of fuel for war planes and other machines.

"Hitler's formulas are secret, of course, Mr. Ickes explained, "but we know a good deal about his plants. While we count on some assistance from Britain; nevertheless, we must build our plants of American materials, use American methods, and adapt the processes to American coals. This calls for research and investigation, and for actual construction and operation on a commercial scale."

Mr. Ickes warned that this was not a promise to make synthetic fuels cheaper than natural petroleum products, but a proposal to blaze the path now for private capital to do the job when no more natural domestic petroleum is available and it becomes a question of synthetic fuel or the end of the gasoline age. His plea for synthetic fuels research, he said, did not comtemplate competition with the petroleum industry.

Deputy Petroleum Administrator for War Ralph K. Davies backed up his chief's support of the

(*Continued on page* 80)

A motor run by gasoline produced from coal was demonstrated in Washington when hearings began on a Senate bill authorizing government construction and operation of demonstration plants for producing synthetic liquid fuels from coal and other materials. Shown with the motor are, left to right, Secretary of the Interior Harold Ickes, Senator Joseph A. O'Mahoney, Rep. Jennings Randolph of W. Va., Senator Chan Gurney of South Dakota and Senator Abe Murdock of Utah.

PROBLEM OF OIL SUPPLY ASSUMES GROWING URGENCY

Refusal of Price Administration to Permit Crude Advance Remains Obstacle to Drilling Expansion—Wildcat Activities and Well Completions in First Half of 1943 Below Last Year's Record.

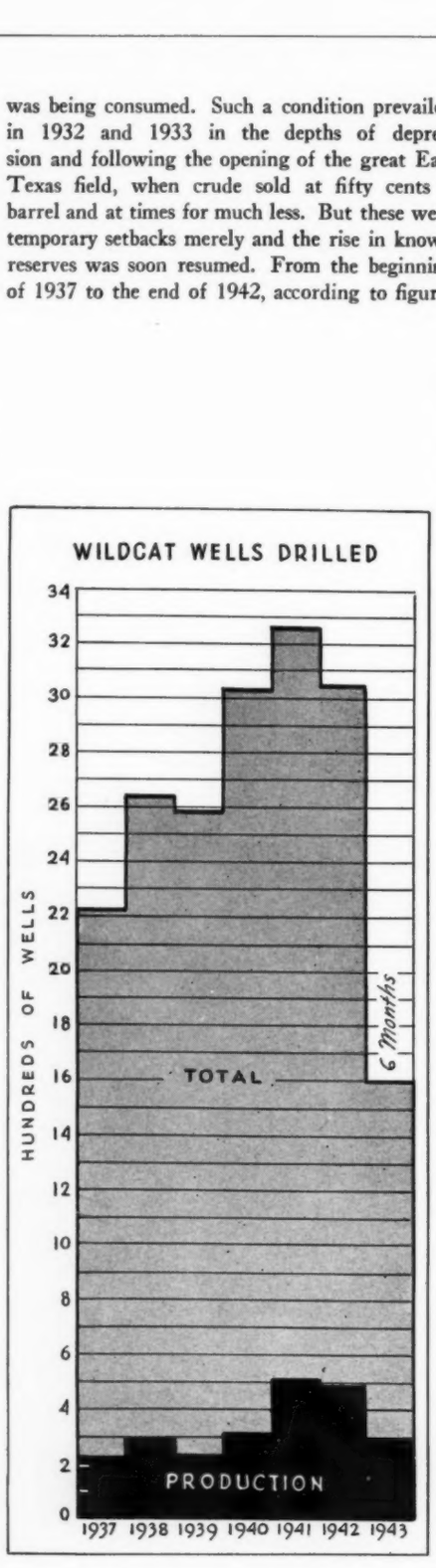
PERIODICALLY during the past sixty years the American people have been warned of the early exhaustion of their oil supply. These predictions were made in all sincerity. They were based on the knowledge of known oil deposits existing at the time and were arrived at by the simple mathematical process of dividing this total quantity by estimated yearly consumption, thereby arriving at the number of years the oil could be expected to last.

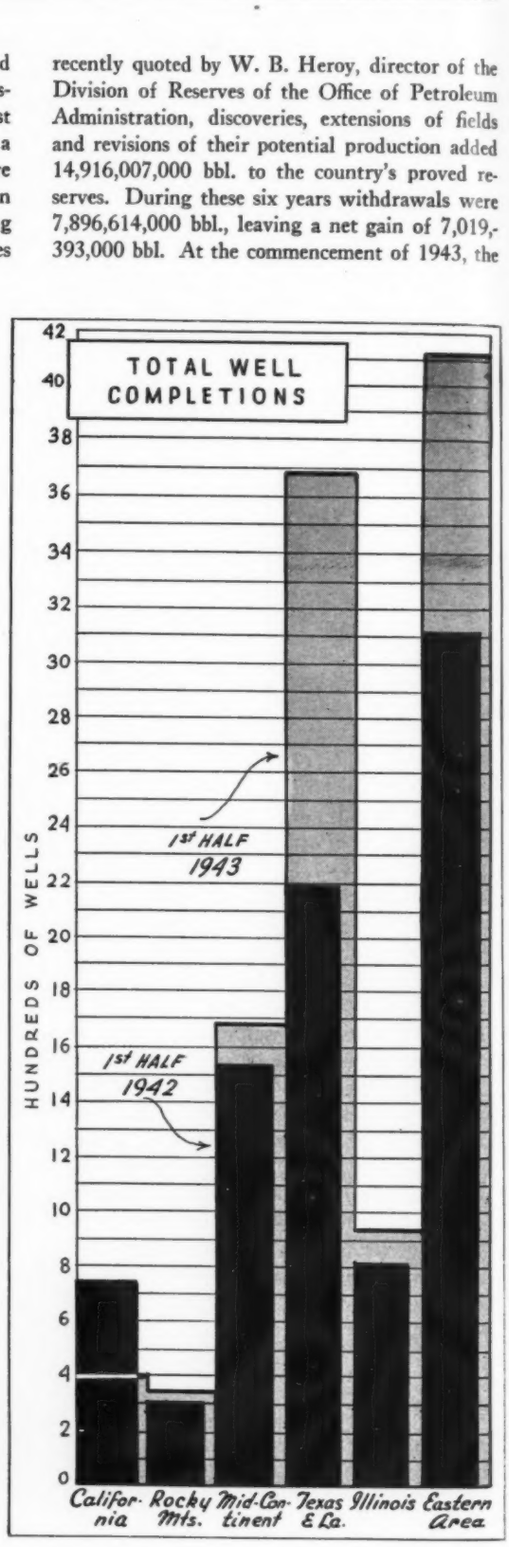
Invariably, however—that is up to the present time—these prognostications have failed to come true. Always, as scarcity loomed ahead, the price of oil advanced and venturesome spirits, spurred by the possibility of glittering rewards, carried the drill to new territories and put down new tests based sometimes on geological surveys and often on "hunches" or the mysterious divinations of doodlebugs. Some of them gambled their own money; the others raised a stake by persuading investors to share the risk and the prospective riches.

These were the wildcatters who carried the search for oil across the continent. Most of their ventures ended in dusters—dry holes that had to be abandoned when the money ran out—and the faith of the financial backers waned. Enough successes were scored, however, to keep the hunt going and now and again a really great field was uncovered, bringing an oil rush of prospectors and promoters from all parts of the country to that particular district. The bringing in of a great flush field occasionally sent the price of crude plunging down to a level that slowed up the wildcatters for a time but the demand for oil soon took up the slack and as prices recovered, the hunt regained its attractiveness and resumed its intensity.

Over the years the price curve and the curve of drilling have moved together. When prices rose more wells were drilled—more dry holes but also more producers. When prices fell drilling slumped temporarily. Although the nation's appetite for oil increased tremendously with the progress of the autmotive age, the drillers kept up with it—or usually somewhat ahead of it. The volume of known reserves grew to such tremendous figures even when prices were declining that most people gave no thought to the possibility that oil might ever cease to flow as freely, almost, as water.

There were years, even during this period of mounting reserves, when less oil was found than was being consumed. Such a condition prevailed in 1932 and 1933 in the depths of depression and following the opening of the great East Texas field, when crude sold at fifty cents a barrel and at times for much less. But these were temporary setbacks merely and the rise in known reserves was soon resumed. From the beginning of 1937 to the end of 1942, according to figures recently quoted by W. B. Heroy, director of the Division of Reserves of the Office of Petroleum Administration, discoveries, extensions of fields and revisions of their potential production added 14,916,007,000 bbl. to the country's proved reserves. During these six years withdrawals were 7,896,614,000 bbl., leaving a net gain of 7,019,393,000 bbl. At the commencement of 1943, the





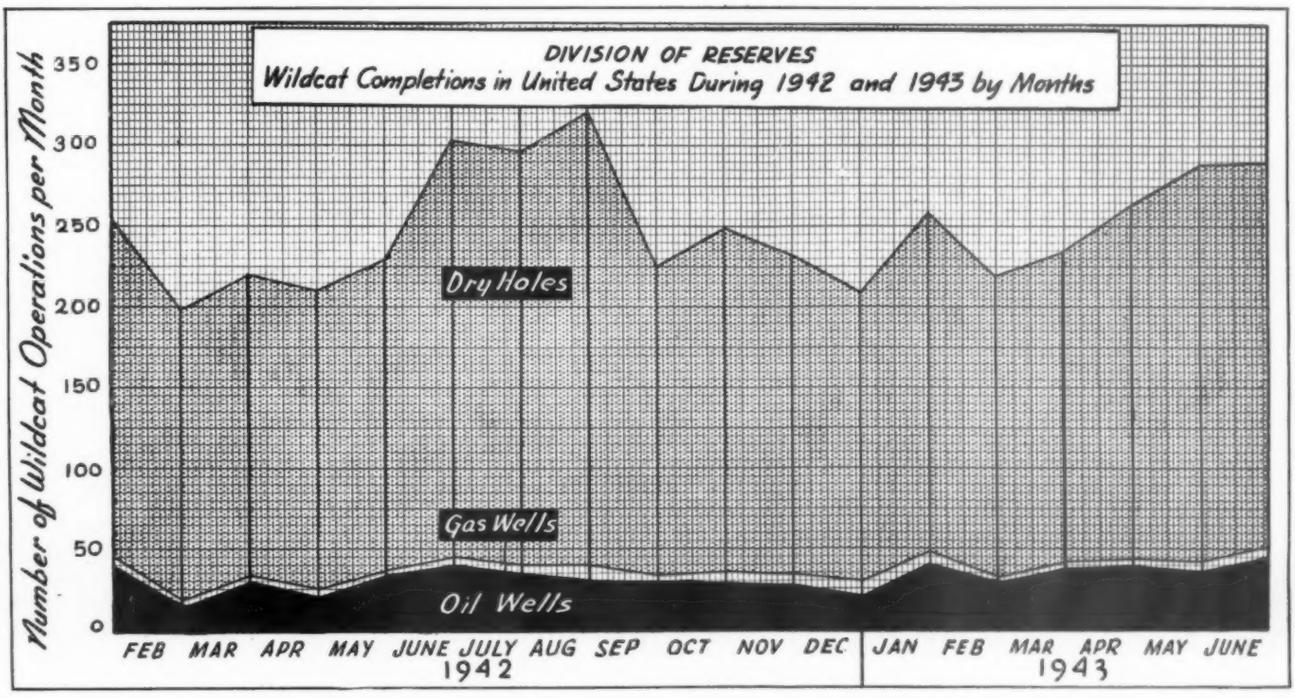
total known reserve was computed at slightly over 20,000,000,000 bbl. At the rate of consumption in effect before the war reached the proportions it is now assuming, this supply would have lasted a matter of fifteen years but that prospect would give no cause for concern if the country were continuing to locate each year nearly twice as much oil as it consumed. As Mr. Heroy hastened to point out, however, the significant point is that the amount of annual additions has been decreasing in the past few years and the volume of discoveries in particular is falling off. The tide has turned from flood to ebb and the consequences if that movement is allowed to continue are obvious and disheartening.

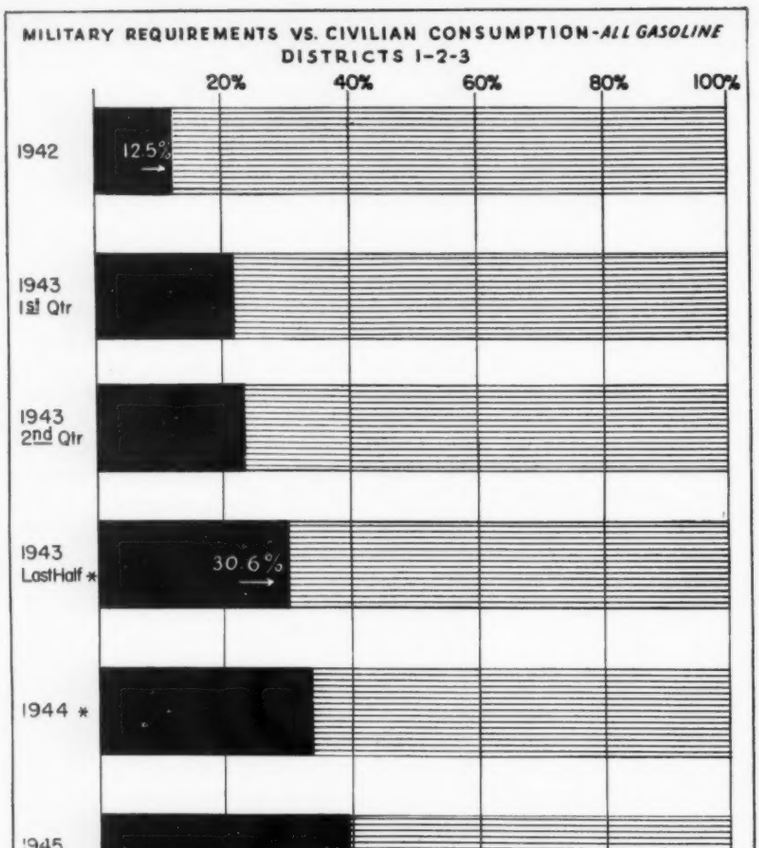
Since war came to the United States, the oil industry has been operating under new and unusual conditions, not only the conditions imposed by the war itself but with prices arbitrarily frozen by governmental decree at the low levels of 1941. Throughout the months preceding Pearl Harbor the industry was warned against drilling "unnecessary" wells and regulations were put in effect intended to enforce this restriction in order to conserve steel for other uses. These limitations did not apply officially to wildcat drilling but the assumption was that oil was plentiful and needed no encouragement to increased production. Output was at a record peak and the only shortage was one of transportation to the eastern states. There was even a denial of authorization for the action needed to relieve this although the oil companies were prepared to provide such relief by building two great pipe lines on their own responsibility and at their own expense. Only a few farsighted individuals within or outside the oil industry could envision the growing certainty of a tremendous rise in the demand for oil that would strain the resources of the country great as these appeared to be.

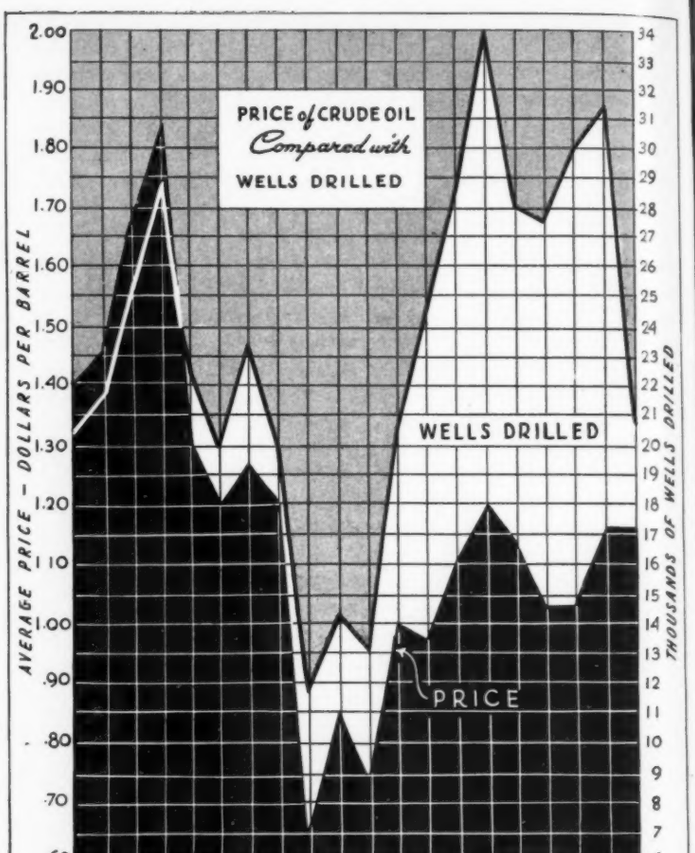
With the incentive to exploration and drilling replaced by officially sponsored obstacles the drilling of wells dropped off sharply at the very time when it should have been expanding. The total of wells drilled fell to 18,000 in 1942, as compared with 30,000 in 1941. Wildcat completions declined only slightly but the quantity of oil added to reserves through such drilling was only about one-third of that obtained from fewer wells in 1940 and less than one-sixth of what it had been in 1937. It became clear to those who were willing to look facts in the face that oil was being used at a rate far above that at which it was being found, that additions to reserves from extensions of existing fields could not maintain the balance for long and that the country was confronted by the choice of locating new sources of supply or rapidly drifting into a position where it could not satisfy its own needs, let alone exporting millions of barrels to other parts of the world. The cry of wolf on previous occasions of apparent crisis had proved a false alarm but this time the wolf was visible and steadily drawing near the door.

Among the geologists of the country who should know most about the future possibilities of oil and among men of long experience in the industry the belief of the great majority is that a vast amount of oil remains undiscovered in the United States. But it is admitted that the cost of locating these undiscovered deposits is becoming greater as it becomes necessary to drill more difficult and less favorable areas, to go to greater depths, and as the size of new fields diminishes and the number of dry holes that must be drilled to find one producer grows larger. It is impossible to expect individuals or companies to prosecute the search for new oil when there is little hope of recovering the funds that are put into the effort and practically no chance of profit. Even without the heavy increase in the cost of materials and labor that has taken place in the past two years, the loss of manpower and the difficulty of obtaining machinery and supplies, the price at which oil was selling in 1941 would not have sustained a campaign of exploration sufficient to maintain the country's reserves at a safe level for current and future needs. Except for the "ceiling" imposed by the Office of Price Administration, oil prices would have risen, possibly in step with the advances in raw materials and manufactured products in every other line. There might still remain a problem of oil reserves but it would be nothing so acute as the problem which exists today of meeting the rapidly rising requirements of the war without either destroying the future productivity of the country's fields or disorganizing its capacity for the production of other war materials.

Two years ago the need for an advance in the price of crude oil would permit increased drilling activity and prevent the premature abandonment of wells of small production that no longer could be operated at the existing price level was called to the attention of the Price Administrator. A formal request for permission to pay a higher price was filed. The buyers of crude oil were prepared to pay the increase then asked for but action was postponed. Since then blunt warnings of possible difficulties in meeting the demands of the war, including lend-lease commitments, have been voiced by men acquainted with the trend of







events and in particular by military authorities charged with responsibility for war supplies. Reports of declining discoveries, statistical exhibits, confidential calculations showing the steady progress toward an unbalance between requirements and supplies have been put before the Price Administrator. Reiterated recommendations by the Petroleum Administrator for War of an advance that would alleviate conditions in some measure have been rejected and the situation has been allowed to deteriorate to the point where it is now considered necessary to canvass the possibilities of obtaining oil for war purposes from whatever oil producing areas are under the control of the United Nations.

At a committee hearing on the military appropriations bill last month the following calculation of the situation for the immediate future was presented:

	Annual (B/D) Average maximum efficient productive capacity from known fields	Annual (B/D) average minimum essential requirements
1943...	4,421,500	4,100,000
1944...	4,212,000	4,400,000
1945...	4,022,500	4,400,000

These figures were prepared for Congress by the Petroleum Industry War Council. In military circles they are considered to be decidedly conservative as to probable minimum requirements which are variously estimated at 4,600,000 barrels daily or upward for the next two years. Accepting them at face value, however, they are sufficiently disturbing for they point to a deficit of 188,000 bbl. daily in 1944 and one of 377,500 bbl. daily for 1945, a total of nearly 138,000,000 for the latter year.

Efforts to increase the rate of drilling during the current year have met with little success. Concerned at the poor showing in 1942 when 261 new fields discovered were estimated to be capable of producing only 1,200,000 bbl. per field, the Petroleum Administrator for War asked for an increase of 50 per cent in the drilling of wildcat wells in 1943, a total of 4,500 against the 3,000 drilled last year. Later on the projected goal for wildcats was raised to 5,200. For the first six months of the year the records published by Oil Weekly show 1,503 wildcat completions compared with 1,519 for the corresponding period of 1942. This leaves approximately 3,700 wells to be completed in the second half of the year to reach the goal set by the Office of Petroleum Administration. Of this there appears to be small likelihood and even if it were attained it would be inadequate to the expanding demands faced by the industry unless the new fields found were of greater capacity than the recent average. In certain respects the results of exploratory drilling in 1943 are encouraging. The proportion of productive wells to dry holes was higher than in 1942 and in a few areas, notably in West Texas, the wells brought in give promise of development into fields of first-rate importance. But the whole activity is on too small a scale due to conditions previously explained.

Of new wells, including oil and gas wells and dry holes drilled during the first six months of the year, according to official figures, the number was 7,976, as compared with 9,483 in the first half of 1942. Productive oil wells numbered 4,415, as against 5,675 in January-June, 1942. Total completions by sections, including input wells and deepenings, according to the authority previously quoted were as follows:

	Jan.-June, 1942	Jan.-June, 1943
Eastern States.....	4,127	3,111
Illinois	931	814
Mid-Continent	1,686	1,543
Texas & Louisiana.....	3,698	2,186
Rocky Mt.	329	299
California	386	742
Total.....	11,157	8,695

It is perhaps significant that the one important area in which a substantial increase was recorded this year is California where a small price increase was allowed early in the year.

In contrast with wildcat activity development drilling is somewhat ahead of the schedule proposed by the Division of Production of the Office of Petroleum Administration at the beginning of the year which called for only 11,600 development wells. That figure was adopted, however, as a deliberate sacrifice of expansion in fields already in production in favor of more intensive exploration to locate new fields, the choice being dictated by the unwillingness of the War Production Board to allocate critical materials for both. In the five years preceding 1942 the average number of wells drilled yearly was roundly 30,000.

Out of the debate and discussion over the position of oil reserves and current needs certain facts emerge which are undisputed outside the Office of Price Administration. Among these are the following:

(1) "Safe" production from existing oil fields so located that they can be drawn upon immediately is inadequate to meet total requirements as the Allied offensive gets into full swing. This does not mean a shortage of oil for war purposes. It does mean that meeting the country's export commitments will require the forcing of production at a rate that may sacrifice future recovery from existing fields or a curtailment of domestic use seriously damaging to the nation's internal economy.

(2) The present extent of known reserves is not great enough to support the greatly increased rate of production demanded by existing conditions taking into account the time required to recover this oil efficiently.

(3) The average size of new fields discovered has fallen rapidly in the past few years. The amount of oil obtained for each wildcat well drilled is declining. Additions to reserves from discoveries in 1942 were the smallest in ten years.

(4) During the past five years the quantity of new oil discovered has been far below the quantity consumed. The high total of reserves has been maintained only by extensions and revisions of existing fields which must inevitably decline as these fields grow older.

(5) The cost of all drilling has risen greatly and the expense of exploratory work has increased in still greater proportion while the price of oil has been held at an uneconomic low level and is far out of line with the general commodity level.

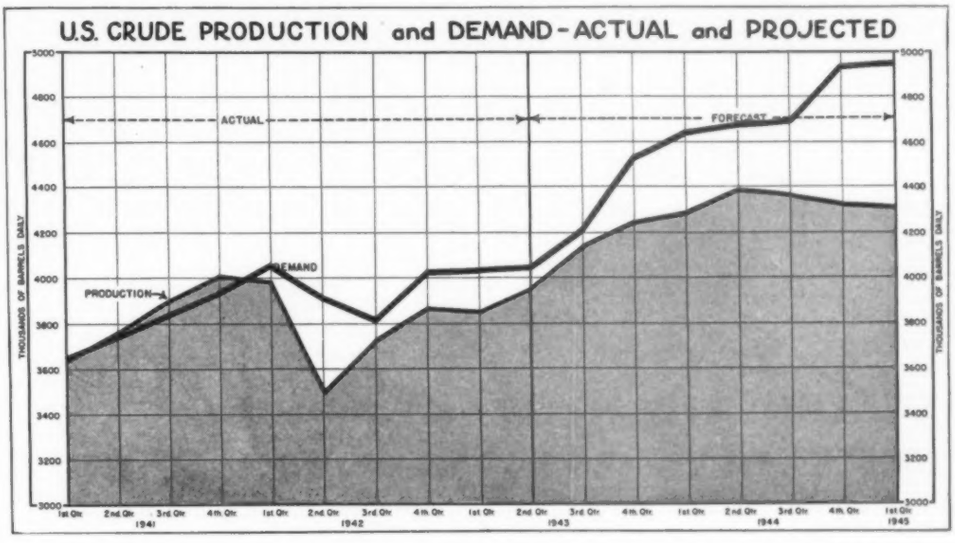
(6) To maintain reserves and production at a level sufficient for current and prospective needs the number of wildcat wells drilled annually should be two to two and a half times the number actually being drilled. The drilling of development wells should be increased within the limits of proper conservation which are capable of expert determination.

(7) The expansion of drilling activity is prevented by the practical certainty that capital invested in it will be lost, taking into account the high cost involved and the low price of oil obtained from the one productive well out of eight holes drilled, resulting in a pay-out period exceeding the probable life of the well.

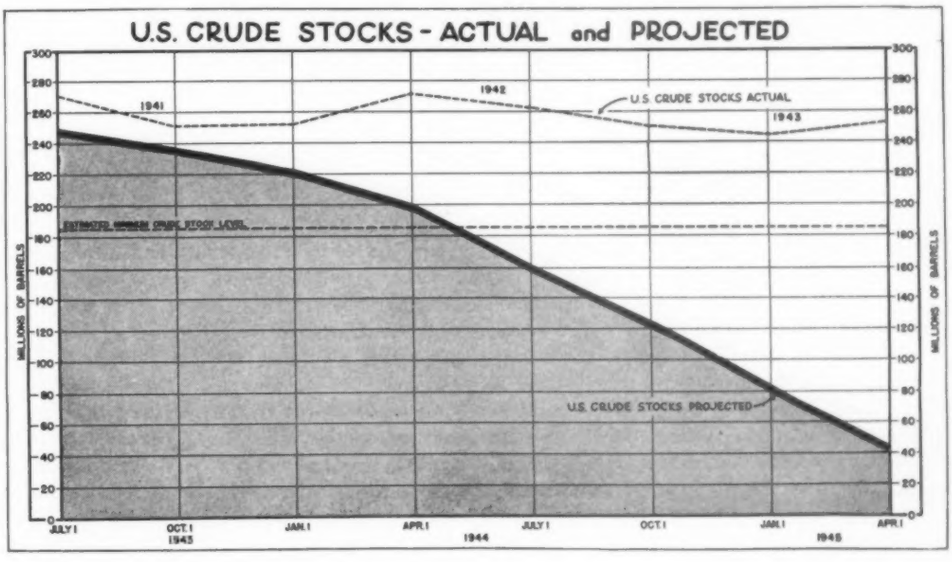
(8) The existing price level is causing the loss of oil known to exist and capable of recovery. It does this by causing the abandonment of thousands of stripper wells and the prevention of measures of secondary recovery, involving a possible loss of 2,000,000,000 to 3,000,000,000 bbl. of recoverable oil.

(9) Division of governmental authority over oil industry operations with decisive control in the hands of the federal Price Administrator threatens the future industrial supremacy of the nation which, like the successful prosecution of the war itself, rests upon rising production and abundant supplies of oil.

The fundamental error in the treatment of oil by the Office of Price Administration which really holds the key to this situation has been the failure to recognize the essential place of petroleum in the conduct of the war. In planning for the necessary supplies of other vital materials—ships, tanks, planes, munitions, and many others—and in providing the facilities to produce these supplies, the procedure has been to take whatever steps were required to insure adequate production. Plant equipment was expanded either by private capital or with the government's financial aid if needed. Critical materials were alloted to insure rapid construction. Contract prices were fixed sufficiently high to assure protection to private investment and to afford a reasonable profit on each undertaking. This policy was applied to the production of specialized petroleum products which were outside the jurisdiction of the Office of Price Administration but it has been denied by that agency to the basic factor of the industry, the factor of production from which all products must be derived. Yet the oil emergency differs from these others in that it is not confined to the period of the war. Whatever increase may take place in the country's oil plants, represented by its producing wells, will still find useful employment after the return of peace and will strengthen the national economy when such strength will be greatly needed. The consequences of this misdirected course of action already have become embarrassing to the nation; they are capable of becoming disastrous.



Charts prepared by Office of Petroleum Administration



Over-all view of Sun Oil Company's new aviation gasoline plant. The size and magnitude of this equipment is illustrated when it is considered that the tower on the extreme right is approximately as high as a 15-story building.

ALLIED AIR STRENGTH WILL BE FED BY EXPANDING AVIATION FUEL PRODUCTION

Facilities Still to Come into Operation will Greatly Increase Production of 100-Octane Gasoline by the United States—Supply Will Be Supplemented from Other Sources.

THERE are two phases of petroleum's participation in the war that military authorities have felt it necessary to surround with a high degree of secrecy. One of these is the overseas tanker movement and the other is the exact production of aviation fuel. In the former case it is obvious that knowledge of the movement and destination of shipments of any kind would be of direct value to the enemy as indicating probable points of attack and would be fraught with grave danger to our own ships and men by providing guidance for enemy submarines. While information as to the production of 100 octane gasoline is perhaps of less direct value to the enemy it is felt in official circles that it might serve to some extent as a means of appraising him of the strength of bomber attacks to be anticipated and in aerial warfare the element of surprise is highly important.

It is no secret however that the main source of supply of aviation fuel for all the United Nations is the United States. Events of the past few months in Africa, over Europe and in the Pacific have demonstrated that the quantity is tremendous judged by anything the world has heretofore witnessed in the way of air operations. There can be no aid or comfort to the enemy in the realization that allied air power is many times greater than anything that he can marshal nor in the added fact that it is rapidly growing to overwhelming proportions. Contemplation of that condition is much more calculated to cause him to experience acute discomfort and foreboding.

While it is still deemed unwise to reveal precise statistics of output of aviation fuel or of shipments to the various battle areas it is permissible to give some indication of the rapid expansion in its manufacture, the number of units contributing to the high octane program and the extent to which facilities now in process of construction will enlarge the output under the existing program which of course is subject to revision upward should that become necessary. Some fragmentary figures have been released from time to time as to the quantity of fuel consumed in a single bombing raid or by a particular air command operating on some one segment of a world

wide battle area. The President himself in a recent broadcast made mention of the fact a Flying Fortress traveling from North Africa to Naples consumed 1,110 gallons of gasoline on the trip. Such figures while highly impressive have little relation to the total quantities required because fuel requirements vary greatly according to the types of planes involved as well as in the distances traveled and because bombing raids while highly spectacular are only one of many uses to which such fuel is put. Similarly, a statement of the number of American refining units contributing to the mounting flow of high octane reveals nothing of military importance because some of these units are of very large capacity while others supply relatively small amounts. The facts that may be put on record however are sufficient to be a source of satisfaction to the people of the United Nations and to their Allies as to achievements up to date and a basis of assurance for the future.

In January, 1942, there were 22 refineries within the United States which were making some 100 octane gasoline or some major ingredient such as base stock or blending agent. In June, 1943, there were 47 such refineries. While each one of these 47 refineries was making 100 octane gasoline, construction of still more new facilities was in progress at 28 of the 47 refineries. When all of the construction work in progress in this group of 47 refineries is completed, they will be able, collectively, to produce 85 per cent more aviation gasoline than they produced in midyear, 1943.

There are 26 other refineries in the United States which are scheduled to make 100 octane gasoline and in which plants for that purpose are now in the course of construction. In the next six months more and more of these 26 plants will go into operation. In addition to the 47 refineries now producing 100 octane gasoline and the 26 refineries which are still scheduled to produce the product but which are not yet in production, there are 72 refineries which in June, 1943, were making codimer. This codimer after hydrogenation becomes a valuable blending stock which goes into the current production of aviation gasoline. The collective contribution of these 72 refineries to the present production of 100 octane gasoline is greater than that of any single present producer except the two largest. However, some of these 72 refineries which are producing codimer are also producing or are scheduled to produce 100 octane gasoline as well. This gives a total of 126 domestic refineries which are contributing or which are scheduled to contribute to the ultimate production of 100 octane gasoline.

In January, 1943, the refineries of the United States produced several times as much aviation gasoline as they did the year previous, in January, 1942. However, very few new 100 octane units, construction of which started after the war commenced or just prior to the war, were in operation in January, 1943. The expansion made in production was made by other emergency measures. One of these measures was to increase the amount of tetraethyl lead in 100 octane gasoline. Another was to remove the bottlenecks in the existing plants. Still a third very important expansion was obtained by utilizing prewar facilities in other refineries for the production of certain special ingredients. Finally, a very large increase in production was obtained by running all of the refineries as one in the sense that the components available were blended in ways that produced the most gasoline regardless of the companies and refineries in which these components originated.

When all of the plants now scheduled to be completed are in operation, the amount of gasoline which they will produce will nearly double the output up to April or May 1943 and will approximate the highest demand yet indicated by the Military. Means of expanding this output will still be available however as is illustrated by happenings in recent months. Since the middle of April, 183 separate 100 octane construction projects have been approved by the Petroleum Administration and by the War Production Board. Of these 183 projects, 71 were of such a nature that less than $10,000 needed to be expended and 46 more came within the bracket between $10,000 and $50,000. Only 27 of the 183 projects involved expenditures of as much as a million dollars.

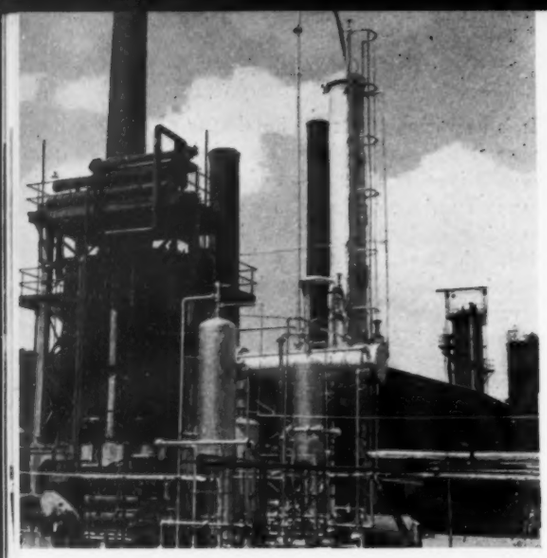
It is well known that the installation of a complete 100 octane unit in an existing refinery usually involves the erection of a catalytic cracking unit and an alkylation unit as well as certain auxiliary equipment and that in the spring of 1942, the average cost of such a unit was estimated at about $2,400 per daily barrel of 100 octane gasoline. The difference between the type of projects which have recently been approved and most of the fundamental projects of last year is due primarily to the fact that as experience in 100 octane production grows it is found that small changes in plants operating or about to operate will produce considerable increments of products. Hence, the expansion which is likely to occur in manufacturing facilities from now on is one of relatively small changes in units already authorized rather than in the expenditures of material to build new units from the ground up.

While the present production of 100 octane gasoline in the United States is of record dimensions and its consumption on the world's battlefronts exceeds anything recorded in past history both production and consumption are on the way to being very largely increased as a result of facilities which are coming into operation week by week and which will continue to expand at least until well into 1944. Furthermore, there is a reasonable expectation that the output called for in the design of these new or transformed plants will be increased as the plants get into settled operation and as improvements are made in the processes which they employ. It may be pointed out that of the three catalytic cracking processes now chiefly employed for the production of high octane fuel two were not even in commercial operation at the beginning of the war and that very definite advances in efficiency have been made by all of them since the first construction orders were placed.

While the huge new catalytic cracking units of great capacity, each representing an investment of many millions of dollars, have received the principal share of the limited amount of limelight that has been permitted to play on any part of the high octane program there are other processes which play an important if relatively smaller part in this program.

There are for example several projects which involve the use of butane gas rather than liquid petroleum as a raw material. The light hydrocarbon stream usually obtained as a by-product of natural gasoline manufacture is cracked to produce raw materials for alkylate and the alkylate is blended with a base stock obtained from natural gasoline. As a variation of this, isobutane, if not available in sufficiently large quantity in the butane stream, is made by isomerization the same as it is in other installations which rely on gas oil or similar charging stocks for butane availability.

The present program also includes a few uses of cracking processes which depend for their excel-



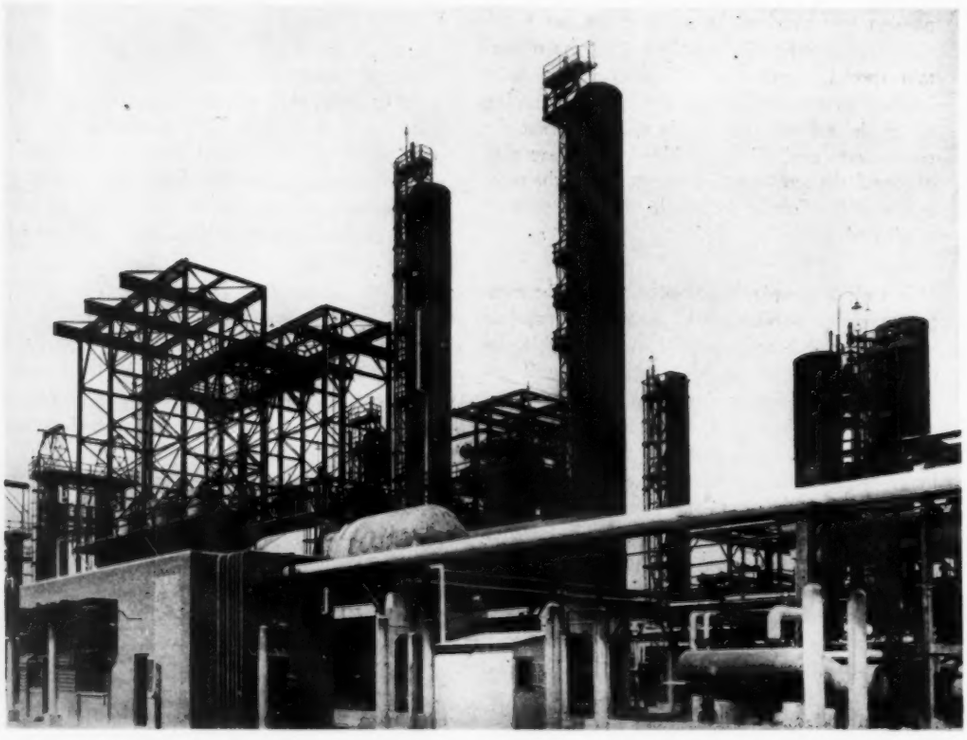
Catalytic polymerization unit in a plant in the Eastern part of the United States.

lence partly on the selection of a particular cracking stock. However, this type of process is the exception rather than the rule. The catalytic isomerization process has also been adapted to work on a heavier hydrocarbon such as the pentanes and hexanes in order to provide high octane volatile components for base stock. It remains true however that most of the 100 octane installations now built or building have depended primarily on the installation of a catalytic cracking unit to produce high octane base stock and to produce the necessary components for alkylate manufacture. These plants have, of course, also included an alkylation unit along with the catalytic cracking unit. Some of the plants include units to produce isobutane by isomerizing normal butane.

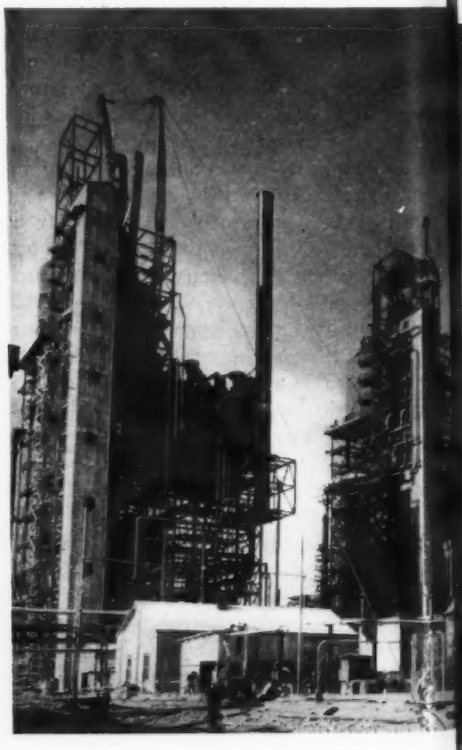
The Office of Petroleum Administration has taken pains to point out that whatever the relative number of the different types of units may be, the number does not necessarily reflect the relative excellence of the different types of processes. One reason for this is that some of the 100 octane units were designed before the war, some in the early stages of the war and some only currently. When a decision was once made to use a particular type of process and when engineering, purchasing and construction work had commenced, the Petroleum Administration could not permit a refiner to change his mind merely to attain a higher degree of predicted excellence. The need for 100 octane gasoline has been too great to permit "second guesses". It must be borne in mind that the relative excellence of each of the various types of catalytic cracking processes depends a good deal on the use that is to be made of the particular cracking unit. Local excellences exist. One type of operation may be better to make butylenes and not quite so good to make base stock, and vice versa. Further, technology is advancing so rapidly that any conclusion reached at the present writing concerning the relative excellence of one process over another is very apt to be quickly overturned.

What was notably true in peacetime about refinery technology is still true in wartime, namely, that while the proponents of various new processes are at first very much impressed with the difference between their process and those of their competitors, as time goes on the process features tend to grow together even though they have separate origins, and each process tends to look more and more like each other process. This, of course, is the result of the gradual adaptation by one process of what it can use of the developments of another process. This tendency, noticeable in peacetime, has been augmented in wartime due to the voluntary cooperation of the oil companies and the complete freedom of cross licensing which exists during this war. One of the most valuable forces in the production of aviation gasoline has been the Aviation Gasoline Advisory Committee appointed by the Petroleum Administration, which committee acts as an arm of the Refining Division of PAW. The committee members were deliberately selected because of their personal experience in this field and they were naturally enough selected from different companies using different processes in order to make sure that the Administration would have available the best possible cross section of technical thought. It is interesting to note that the members of this committee and the supporting

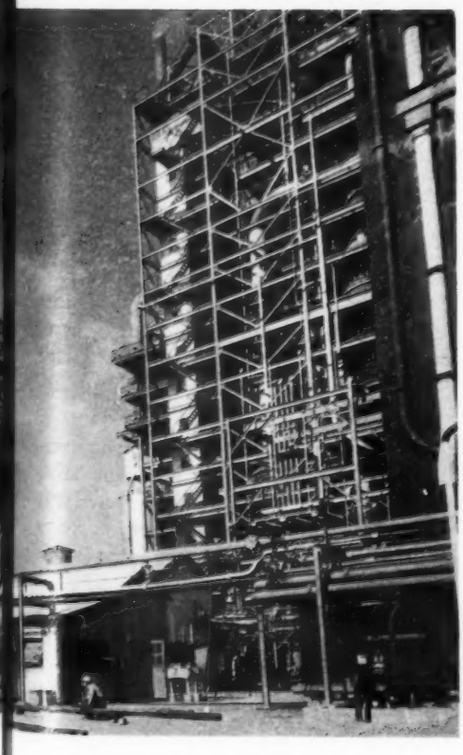
Alkylation plant at one of the refineries of the Sun Oil Co. The two large towers in the center are deisobutanizers.



New fluid catalytic cracking units of the Standard Oil Company, Baton Rouge.



Night view of alkylation unit at Shell's Wood River refinery.



sub-committees are able to work together peaceably and to exchange data with respect to their various processes with the result that each man knows all that he reasonably needs to know about any process.

In certain lines of production the plants erected to supply war needs have been largely or wholly financed by government funds. Nearly all the plants built to provide munitions or the raw materials for synthetic rubber are owned by Defense Plants Corporation, itself a government owned concern. The high octane program has been an exception however. Approximately 75 per cent of the production of aviation fuel comes from plants privately financed by the oil companies themselves. Even in cases where funds for erection or reconstruction have been provided by Defense Plants Corporation the plants themselves have followed the plans drawn by company engineers subject to approval by governmental agencies and the plants are operated by refiners to whom loans or leases have been given. The success of the high octane program is primarily an industry success, supported by the cooperation and backing of the Petroleum Administration, the War Production Board and as to 25 per cent of the program by the financial representatives of the government.

While the refining industry of the United States, as often has been stated, has assumed a major part of the responsibility for providing 100 octane gasoline for the Allied forces it should be borne in mind that others of the United Nations possess refineries producing and supplying this type of aviation fuel. Some of these facilities are being expanded and as the war progresses larger quantities of this essential war material will be drawn from these other sources. The petroleum problems of the Allies are numerous but as far as the supply of aviation fuel is concerned there is definite assurance that all imaginable needs will be met through steadily expanding production.

Black smoke from burning oil shoots skyward emanating from the Colombia Aquila refinery in the Ploesti oil region in Rumania. Some of the Liberators that carried out this destruction can be seen aloft.

ALL AXIS OIL SUPPLIES NOW OPEN TO ALLIED AIR ATTACK

As THE pattern of the allied aerial offensive against the Axis gradually unfolds it becomes evident that it is following a carefully prepared plan. This plan is directed to the systematic destruction or disorganization of the sources of enemy war strength. It proceeds step by step from one objective to another, taking these not necessarily in the order of their importance but according to the conditions that govern the range and effectiveness of air attack. Recent events have indicated quite clearly that this campaign of devastation from the air has reached a stage where more concentrated attention can be directed toward one of the most vulnerable links in the Axis coat of defensive armor—its essential oil supplies.

In the early stages of British bombing attacks upon the continental dominion of the Nazis oil depots and oil refineries were favorite targets and considerable damage was done by blowing up storage tanks and starting fires in refining centres. At that time however the number of planes that could be employed in each raid was not sufficient nor the weight of bombs that could be dropped heavy enough to cause more than temporary injury. Later on when mass raids by hundreds of bombers became possible, wholesale attacks upon centres of war production were undertaken. The whole great industrial area along the Rhine was swept by air armadas that practically erased whole cities and that returned again and again to discourage attempts to repair the damage inflicted.

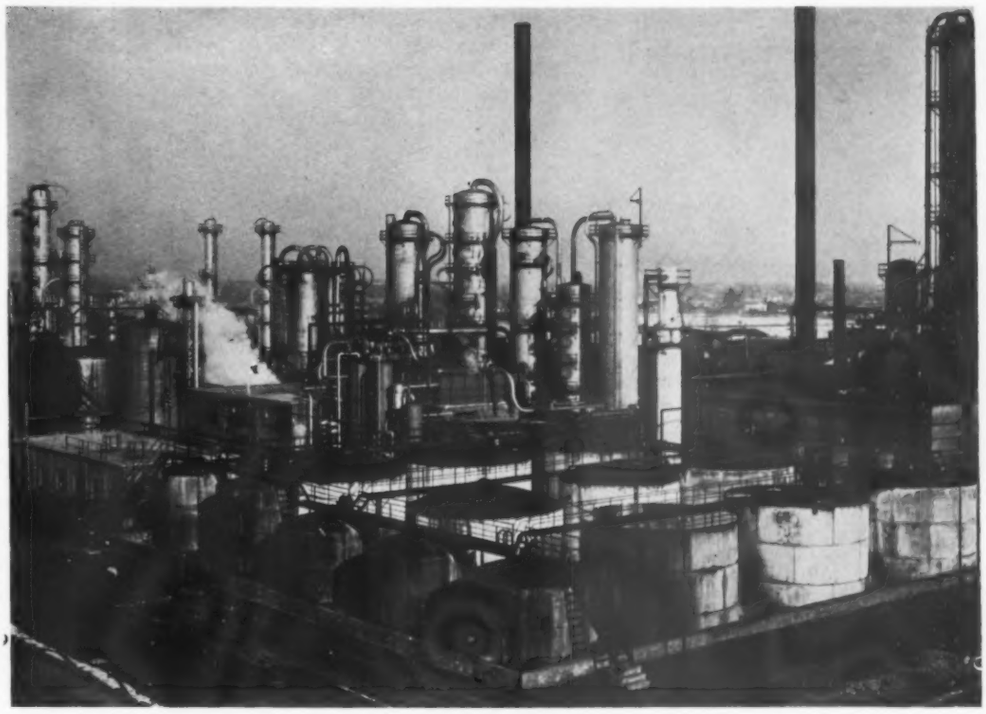
In the course of these repeated assaults the refineries and synthetic oil plants located in the Ruhr area, some of them of large capacity, undoubtedly shared the fate of other war plants in that part of Germany and were more or less permanently put out of commission. That these assaults were not without effect was shown by the gradual weakening of the Nazi air arm and its inability to undertake effective reprisals against Britain itself. In the meantime, however, the Hitler government had recognized the risks to which war plants in the western portion of the Reich were exposed and had undertaken to establish refining facilities at points further East and supposedly beyond bombing range.

Now, with the multiplication of Allied air strength to the point where not merely one but several powerful air attacks can be launched simultaneously and with the closing in of the ring that has been drawn around Hitler's so-called European fortress the time is at hand when any point within Nazi-held Europe can be reached by air attack. Repeated bombing flights from Britain across the Alps have laid waste the industrial cities of northern Italy. Still longer raids covering upward of 2,500 miles have carried Allied planes from North African bases to Hungary and former Austria. No part of the so-called greater Germany or its subjugated neighbors can longer be considered immune from assault by the mighty air armadas of the United Nations. As Allied forces move nearer to the Reich itself acquiring air fields that are only a few hundred miles removed from the war plants and internal communication lines of the Reich the frequency and destructiveness of air attacks will be greatly increased. This changed situation was highlighted dramatically by the daring American raid of August 1 upor the Rumanian refining centre at Ploesti. Reports of the results of this attack indicate that over half of the refining equipment at Ploesti where the bulk of Rumanian oil was refined either was completely destroyed or so badly damaged that it cannot be put back into operation for many months and that millions of gallons held in storage were lost in fires started by the invaders.

The assault on Ploesti was one of the most carefully prepared air raids of the war. To familiarize pilots with their targets a replica of the town was set up in the African desert and the bomber crews practiced flying over it for weeks in order to perfect their timing and to become fully acquainted with their objective. The attack differed from most earlier ones in that the planes flew in at roof top levels enabling them to discharge their loads with deadly effect and to observe the results with unusual accuracy.

According to the reports brought back by the fliers six or seven of the thirteen large refineries in the area were heavily blasted, set on fire and thoroughly crippled, if not entirely destroyed. Among those positively identified were the great Astra Romana plant, largest in Rumania, owned by the Royal Dutch-Shell group, Romano Americana of Standard Oil (N. J.), Creditul Minier, Colombia, Steua Romana and Aquila. The Campini refinery of Steua Romana, about twenty miles from Ploesti, was said to have been completely destroyed. These refineries had a combined daily capacity of over 100,000 bbl., and their loss reduces the efficiency of Rumanian refining plants by fully 60 percent.

In addition to the devastation wrought among the refineries huge storage tanks reported to contain a month's supply of oil were hit by bombs and their contents set on fire. Tank cars were destroyed and the pumping station on the pipe line to Giurgiu on the Danube was blown up putting the line out of commission for a considerable time at least. For a single raid the attack probably was more seriously crippling to the enemy than any previous attempt.



Colombia refinery in Ploesti prior to the damage inflicted by U. S. planes carrying delayed action bombs.

Chief significance of the Rumanian attack lies in its indication that a coordinated drive against Nazi oil supplies is now under way and that this will include carefully prepared blows against other refineries throughout the Reich and surrounding subjugated countries as well as against railway junction points and transportation equipment. A continuation of these attacks which may be expected to become increasingly devastating as time goes on may very well prove disastrous to Axis defense plans by depriving its armies of the protection which fighting planes alone can give against concentrated ground and air attack along the battle fronts.

On the other side of the world the possibilities of long range attacks even by planes operating in limited numbers and without the heavy bomb loads accommodated by the bigger fleets and individual ships in the European theatre were exemplified by the raid in mid-August against oil facilities in the hands of the Japanese. In a 2,500-mile round trip flight Liberator bombers carried out an attack against a Japanese controlled refinery and storage tanks at Balik Papan on the Island of Borneo. This refinery with its adjacent fields was one of several in the Far East owned by the Royal Dutch-Shell group. It was subjected to a surprise attack during the Japanese sweep through the islands of the South Pacific but was set on fire by the operators before they left it. There have been reports during the past year that the Japanese had succeeded in making sufficient repairs to put it back into operation. The field is an important one because of the high quality of the oil produced and the fact that the wells are of shallow depth making it easy to redrill even though the existing wells were plugged or dynamited. The report of the raid stated that seven large storage tanks, two refineries (the second possibly at Pangkalan Brandan) and one tanker were set on fire, inflicting damage which if not completely destroying the installation will put it out of operation for several months to come.

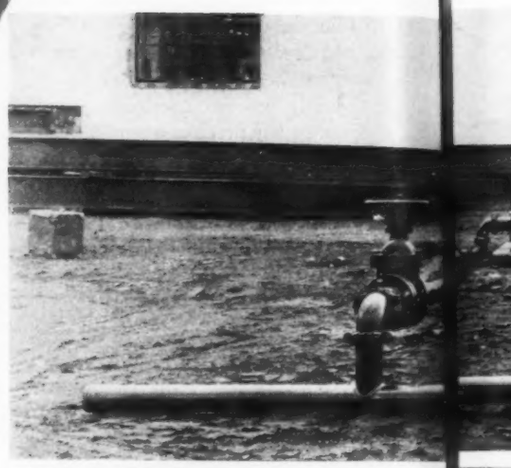
U. S. Liberator bombers skimming over a section of Ploesti at roof top levels. Note smoke in background. Defenders tried in vain to hide objectives beneath a smokescreen.

PORTABLE PIPE LINE AIDS MILITARY OPERATIONS

S. S. Smith, designer of the portable pipeline used by our Armed Forces in North Africa and Sicily. He is manager of Products Pipe Lines for the Shell Oil Co.

Right: Pump station consisting of engine, pump, control apparatus, and tool box, loaded on truck for transportation to scene of operations.

Below: Pump station complete with connections for installation in main line.



ONE of the highly practical contributions to the effective prosecution of this mechanized war, and one that the United States War Department is willing to have publicized, has been made by Sydney S. (Syd) Smith, manager of the products pipe line department of the Shell Oil Company. Some two or three years ago Mr. Smith began thinking about the advantages of a portable pipe line that could be laid and operated by unskilled labor and could carry oil products from field bases right up to the front lines where it was needed.

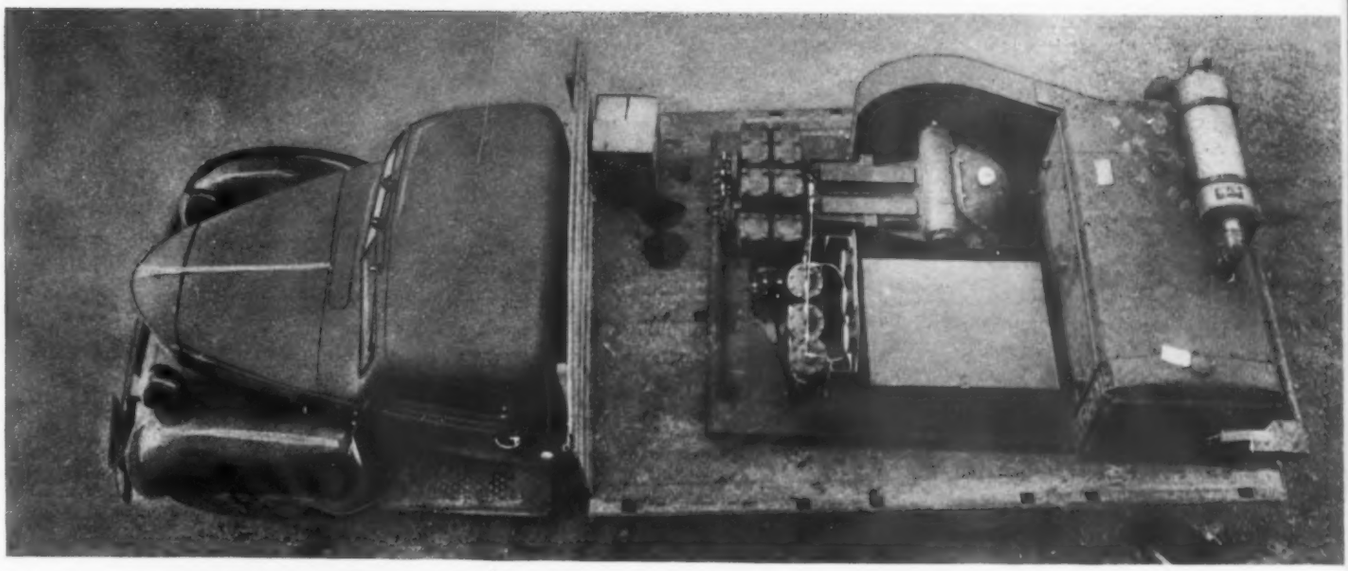
As his thoughts developed into definite plans he committed these to paper and gradually worked out the design for a pipe line that seemed to meet war requirements. He discussed his ideas with Alexander Fraser, president of Shell, and Norman J. McGaw, vice president in charge of transportation with the result that the company appropriated $10,000 for the building of an experimental line in the Middle West. At about the time this stage in the development of the project was reached the problem of moving oil among other supplies over the Burma Road to China was becoming acute and the suggestion of a pipe line for this purpose was brought up. Inspection of the working model constructed by Mr. Smith convinced the authorities in charge that a line such as he proposed would meet their requirements and the Chinese Defense Supplies Corporation placed an order for 1,000 miles of the pipe to move oil into China.

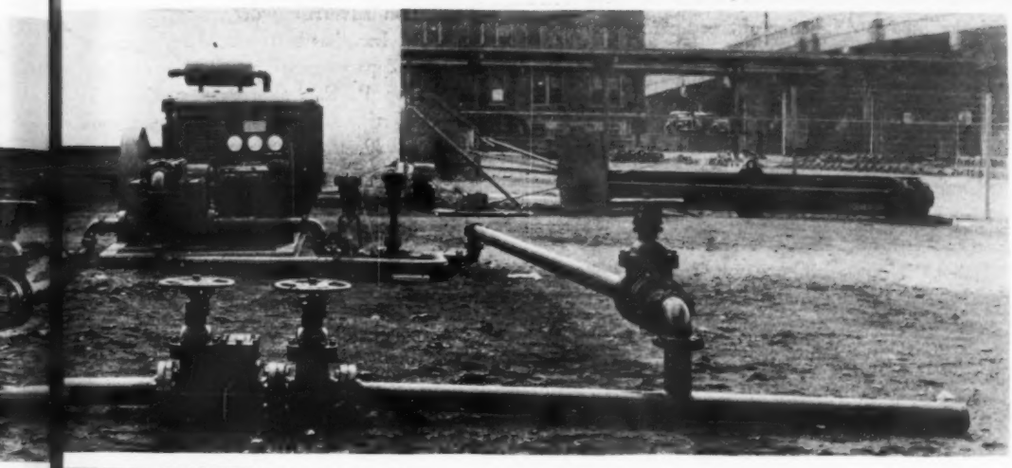
When the request for the steel needed for construction of this line came before the War Production Board the matter came to the attention of supply officers of the U. S. Army who were immediately interested in its possibilities in connection with the operations of American forces overseas. The Army made its own tests on an experimental line in the Shenandoah Valley with such satisfactory results that after the Japanese cut off a large section of the Burma Road making the building of a pipe line there impossible they took over the pipe that had been fabricated and transported it to North Africa where, as later in Sicily, it worked so well that Brig. Gen. Fowler, chief of the Supply Division of the War Department, acting for the Chief of Engineers, wrote a congratulatory letter to Mr. Smith saying that his portable pipe line system has been "a material contribution to the success of our armies in the field."

In order to be suitable for the use of armies in the field a military pipe line must conform to certain obvious requirements. It must be light and capable of being rapidly laid or moved. The pumping equipment has to be simple in operation with automatic cut off in case of damage to the line. These and other technical requirements were carefully worked out by Mr. Smith with the aid of engineers of the manufacturers who produced the equipment.

The line as finally developed is of four and six inch diameter capable of moving 6000 bbl. per day. It consists of light-weight, spiral-welded pipe made in 20-ft. sections. These sections weighing only 90 pounds can easily be carried by one man and pipe can be laid at from 10 to 30 miles per day by regular army personnel. The flexible nature of the pipe permits it to be laid rapidly over rough terrain and makes it less liable to damage by bombing than a rigid line. The ends of each section of pipe are grooved for victaulic couplings.

Light weight gasoline-fueled engines mounted on skids power two-cylinder unit reciprocating pumps to propel the oil and the line will operate effectively at temperatures ranging from 40° below zero to 130° above. The engine equipment including pumping stations weighs approximately 13 tons per mile and can easily be transported by truck. No communication system is necessary. In case of a break the flow of oil is automatically cut off and automatic pressure control prevents trouble. If an individual pumping unit is put out of commission it can be replaced within a few hours and the capacity of the line is reduced only about 30 percent in the interim.





Separate lines naturally have to be used for each product transported. Four or more of these portable lines were in use during the North African campaign varying in length from 75 to over 300 miles and carrying both gasoline and water. They effected a great saving in time and in the use of trucks. An added advantage is that the inconspicuous pipe line lying on the surface is a target much more difficult to hit than a line of tank trucks moving along a highway.

Above: One man alone can handle a 20 foot section of the light weight flexible pipe used in the portable petroleum pipe line, Mr. Smith looks on approvingly as the 90 pound section is carried into position.

Left: The flexibility of the pipe makes it easy to handle and the lines can be laid in a fraction of the time required for normal lines and under actual battle conditions.

Foreign Oil Legion

Bill Maddox

WILLIAM JOHNSTON (BILL) MADDOX has been appointed as Washington representative of WORLD PETROLEUM. He is no stranger to the national capitol being one of those rarely encountered individuals born there. Educated at public schools and at George Washington University he entered newspaper work in Washington in 1913 and has since reported Washington affairs for newspapers, news services and trade publications. Occasional breaks in newspaper work have been service in the army (infantry) during the first World War, short spells of publicity and public relations work, a rather long stretch of freelancing in the magazine field, writing articles of a general popular nature and service with the Republican National Committee during the 1920 campaign.

During the past two years Mr. Maddox has been on the staff of National Petroleum News. He has a wide acquaintanceship in official circles, with members of the oil industry, in and out of the government, and among the members of Congress and others on Capitol Hill. Two sons are in the present war. One, Bill, Jr., is an officer in cavalry (horses) and the other, Notley, is a navigator in the Army Air Force.

AT A COLORFUL ceremony attended by several hundred persons Col. K. B. Harmon, chief San Francisco Ordnance District, on August 11 presented the Army-Navy "E" for excellence in production to R. C. Baker, president of Baker Oil Tools representing the company, and Betty Rice, C. E. Jensen, and A. C. Pazdernik, representing the employees.

FRIENDS and associates of John H. Childress, master mechanic of Lago Petroleum Company, joined last month at a dinner in New York in his honor. Mr. Childress has spent twenty years in the oil industry in Venezuela and has severed his company connection to accept a post in Washington.

STEWART P. COLEMAN, formerly head of the economics department of Standard Oil Co. (N. J.) is director of the newly created Program Division of the Office of Petroleum Administrator for War. The Program Division is charged with the important function of coordinating petroleum supplies for war use both those from the United States and from other countries. Since the establishment of the Petroleum Industry War Council Mr. Coleman has served as chairman of the sub-committee, the working committee, of the Committee on Economics of that organization.

LEE C. MOORE & COMPANY, INC., have announced the appointment of Lloyd G. Ensign as general manager of the company's Eastern Division, to take effect immediately. Mr. Ensign will make his headquarters at the administrative offices in Pittsburgh. Prior to this appointment Mr. Ensign had been with the company for the past five years as export manager and New York representative. The New York office will be maintained and the activities will continue under Mr. Ensign's direction in addition to his new duties.

Lloyd G. Ensign

Presentation of Army-Navy E to Coffeyville (Kansas) plant of Parkersburg Rig & Reel Co. Left to right: John M. Crawford, president; A. G. Evans-Lombe, sales manager; A. Sidney Knowles, executive vice president; D. C. Myers, vice president.

D. C. MARSCHNER, assistant manager of the sales promotion advertising department of Shell Oil Company, Inc., has been named acting manager of that department, according to an announcement by P. E. Lakin, vice president in charge of marketing. Mr. Marschner began work for Shell in 1929, after graduation from Brown University as an honor student. His first assignment for the company was as clerk in the advertising department, and he has held various positions in that department since. Mr. Marschner has been in charge of direct mail advertising, new territory campaigns, jobber advertising programs, and merchandising surveys. As advertising field representative for four years, he coordinated the efforts of the company's service station dealers with its national advertising. In September, 1940 he was brought to New York as assistant to the advertising manager, to take charge of industrial and technical advertising. Since that time his activities have been broadened to cover the entire scope of Shell's advertising and ad-

D. C. Marschner

Truly Universal

ALL catalytic and other petroleum refining processes, research and know-how are made available to every refiner and engineer contractor.

A licensee chooses his own contractor, U.O.P. works with both.

Experts train and educate the licensee's personnel in the new technique.

Technologists maintain continuous plant contacts to impart the latest techniques for the promotion of refining efficiency, progress, and safety.

Universal licensees build for the future.

U.O.P. is not a contractor, manufacturer or seller of equipment—but a pioneer in petroleum research and technology.

CATALYTIC CRACKING	HYDROFORMING
REFORMING	DEHYDROGENATION
HYDROGENATION	POLYMERIZATION
ALKYLATION	UNISOL TREATING
ISOMERIZATION	RETREATING
THERMAL CRACKING	SWEETENING
U.O.P. CATALYSTS	U.O.P. INHIBITORS

COMBINATIONS, MODIFICATIONS AND NEW APPLICATIONS
OF ALL THESE PROCESSES
NEW PROCESSES IN THE MAKING

OIL IS AMMUNITION—USE IT WISELY
Universal Oil Products Co.
Chicago 4, Ill., U. S. A.

UOP

CARE FOR YOUR CAR FOR YOUR COUNTRY
Petroleum Process Pioneers
For All Refiners

The Refiners Institute of Petroleum Technology

D. D. Foster, (left) of Pittsburgh Equitable Meter Co. and H. H. Pigott (Equitable Gas Co.) chairman of the Dutch Treat party of Engineers Society of Western Pennsylvania.

ministration and particularly newspaper advertising and dealer relations. He has also had charge of numerous sales promotion campaigns. His new appointment comes as a result of Shell's long-established policy of making advancements wherever possible, from within the ranks, among men who have grown up with the company and have warranted such promotion by demonstrated experience and ability.

THE OIL AND GAS SECTION of the Engineers' Society of Western Pennsylvania this year substituted a technical meeting for its usual midsummer golf tournament followed by a reception and dinner. The afternoon program was in charge of D. D. Foster, Assistant Sales Manager of The Pittsburgh Equitable Meter Company. B. C. Thiel, consulting engineer for the Cooper Bessemer Corporation, read a paper "Modern Compressor Stations", and James F. Swain, geologist with the firm of Huntley and Huntley, covered the subject of "Interpretation of Driller's Log". Through the courtesy of the Barrett Division, Allied Chemical and Dye Corporation, the group viewed the motion picture "Oil for War—The Story of the 'Big Inch' Line". A "Dutch Treat" reception and dinner followed, under the sponsorship of a committee headed by H. H. Pigott of the Equitable Gas Company.

Arthur T. Proudfit, president of Standard Oil Company of Venezuela, who recently spent several weeks on a business trip to the United States, has returned to the company's headquarters in Caracas.

DR. WILLIAM VIETTI, chief petroleum engineer of The Texas Company entertained a recent meeting of the Houston Chapter of Nomads with an illustrated travel talk on the oil industry of Colombia from which country he had just returned. Other guests of the club were L. G. Huntley, consulting geologist, and John Beverly, formerly with Standard Oil Co. of Venezuela, who had returned to the United States to join the Navy.

William Downs Anderson

WILLIAM DOWNS ANDERSON has retired from his position as a director, vice president and general manager of foreign sales of The Atlantic Refining Company in which offices he had served the company since 1923. Mr. Anderson was born in Philadelphia, in 1874, and attended Girard College, Drexel Institute and the Wharton School of the University of Pennsylvania. He entered the employ of The Atlantic Refining Company in 1898, and prior to his election to offices from which he is retiring he served as assistant secretary and secretary of the company. Mr. Anderson will be succeeded as general manager of foreign sales by A. A. Garrabrant, a director and vice president, who has been acting as assistant manager.

FRED F. MURRAY was elected president of Oil Well Supply Company following a meeting of the board of directors of the company. Mr. Murray succeeds Benjamin F. Harris who resigned some months ago. He has been identified with the oil well supply business since early 1929 and was formerly vice president of the company.

James Tanham, vice president of The Texas Company, has been appointed a member of the War Labor Board, representing industry. Mr. Tanham, who is in charge of industrial and public relations for Texaco, has been with the company for 24 years, starting out as a stenographer in its New York offices.

Mr. Murray is president of the Petroleum Equipment Suppliers Association and a director of the American Petroleum Institute. He attended Stevens Institute of Technology in New Jersey and graduated with a degree in mechanical engineering. He is a member of ASME and AIMME.

ARTHUR G. MCKEE & COMPANY, Cleveland, Ohio, designing and construction engineers, announce the appointment of Dustin W. Wilson as technical director of their petroleum refining division. During the past two years, Mr. Wilson has served as technical consultant of the refining division of the Petroleum Administration for War, in which capacity he has had an important part in helping to develop a war program for the petroleum refining industry. He is widely known as a refining technologist and has been an active chemical engineer for 26 years. He was educated at the University of Maine and at the Massachusetts Institute of Technology where he received a B.S. degree in Chemistry in 1917. For ten years prior to joining P.A.W., Mr. Wilson was associated with M. W. Kellogg Company as a chemical engineer and a sales, engineering and designing executive. He was also a director of the company. Other positions held by Mr. Wilson include those as chemist for the U. S. Bureau of Mines and the Chemical Warfare Service in World War I; chemist for National Carbon Company; Assistant Professor of Chemical Engineering at M.I.T.; Chemical Engineer for Iroquois Gas Corporation; and Vice President of Dry Quenching Equipment Corporation of New York.

No. 1 IN A SERIES OF ADVERTISEMENTS TO PROMOTE CONSERVATION OF THE TIRES ON AMERICA'S CARS. SPONSORED BY PETROLEUM INDUSTRY WAR COUNCIL

This open letter from America's Rubber Director to every Gasoline Dealer reveals new facts on Tire Situation!

...ODUCTION BOARD
...WASHINGTON, D. C.

OFFICE OF
W. M. JEFFERS
RUBBER DIRECTOR

July 15, 1943

IN REPLY REFER TO:

TO ALL GASOLINE AND TIRE DEALERS:

Here are the true facts on the tire situation in America today:

Despite all statements and rumors to the contrary, the Nation's stockpile of new and usable tires is dwindling rapidly and the lowest point in history is going to develop between now and the end of September.

The very few experimental synthetic tires now being made and scheduled to be made during the next few months are just a drop in the bucket compared with the need. I can see no immediate relief. America's newly-developed supply of synthetic rubber must be diverted first to hundreds of military needs. America's rubber factories must concentrate their facilities on the manufacture of the most vital war products first.

For these reasons, even under the most optimistic conditions, we should not expect to get many tires even for essential civilian driving until late this year or mid-1944. Only those drivers whose work is most essential to the winning of the war can count on new replacement tires for at least the next twelve months.

There is a solution to this problem. It is to conserve the largest stockpile of rubber in America today — the tires now on America's cars. This can be done by careful driving, by obeying speed limits, by exercising sensible tire care, and by recapping when necessary.

You owe it to your country, and to your customers, not to let any of their tires to become worn beyond the recapping point. Save the carcass! Once it is gone, for most drivers, it cannot be replaced.

From your standpoint, selling recaps when needed is more than a matter of good business today. It is your patriotic duty, and one of the most important things you can do to help keep America's vital transportation rolling.

FOR VICTORY BUY UNITED STATES WAR BONDS AND STAMPS

Yours very truly,

William M. Jeffers
Rubber Director

THE LETTER AT LEFT, written by W. M. Jeffers, America's Rubber Director, states the cold, unadulterated facts on the tire situation. We want you to read it—every word of it—because it may be the means of keeping you in business.

For, it means that if you and every other gasoline dealer in the United States do not see to it that your customers take good care of their tires, you will not have any customers to service. For once a tire has worn past the re-capping stage, the only thing that tire is good for is the scrap heap.

Keeping your customers rolling becomes more than good business. It is your patriotic duty, and vital to America's transportation!

PETROLEUM INDUSTRY WAR COUNCIL

(Created by The Petroleum Administrator for War)

PRODUCTS CONSERVATION SUB-COMMITTEE

"SAVE THE CARCASS" CAMPAIGN LAUNCHED

As a part of its service to the nation and to the millions of car owners of the country the petroleum industry through the Petroleum Industry War Council has undertaken to back up and to spread as widely as possible the warning voiced a few weeks ago by the Rubber Director that for the great majority of civilian car owners new tires will not be available for many months to come.

B. I. Graves, Chairman of Operating Committee, Eastern Division.

"Even under the most optimistic conditions," said Mr. Jeffers, "we should not expect to get many more tires even for essential civilian driving until late this year or mid-1944. Only those whose work is most essential to the winning of the war can count on new replacement tires for at least the next twelve months." The situation, he pointed out calls for careful driving, obedience to speed rules, particular care of tires and especially for recapping them before they become too badly worn for such treatment.

The last mentioned point is being made the keynote of the campaign which is being conducted to inform the public of the necessity for continued tire conservation. "Save the Carcass—Keep the Customer" is the slogan adopted for the messages directed to service station operators and garage owners by means of posters, cards and advertisements in trade press. Oil companies are cooperating in the movement by sounding a warning to the public at large of the need for tire care and recapping in time through their radio programs and local advertising.

The campaign is being carried out through the Products Conservation Sub-committee of the Petroleum Industry War Council of which Bert I. Graves, vice president of Tide Water Associated Oil Company, is chairman. This is the same committee that conducted the country wide educational campaign last year for the saving of motor fuel and voluntary limitation of driving under the twin slogans, "Oil is Ammunition—Use it Wisely" and "Care for Your Car—for Your Country".

This is the third nation wide campaign in furtherance of the war effort to be undertaken by the Petroleum Industry War Council since its organization, the first being the one referred to above and the second the collection of old rubber for reclaiming which added 460,000 tons to the country's scrap pile. In the present undertaking it is hoped through the service stations and garages to bring the importance of tire saving to the attention of every American car owner. These station and garage men are in direct contact with car users and as Rubber Director Jeffers says, it is not only good business from their standpoint to sell recaps when needed but it is a patriotic service as well.

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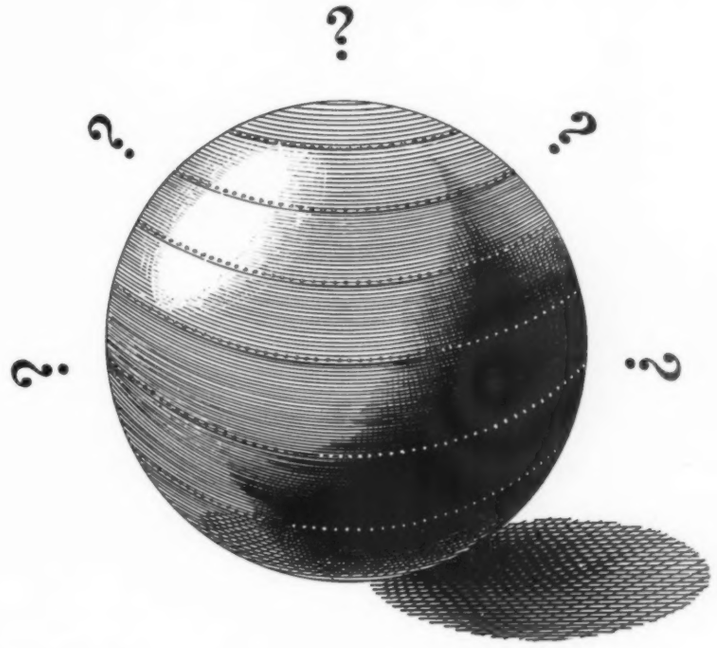

Question: **How can you measure the wall thickness of a continuous hollow steel sphere together with the level and specific gravity of the unknown amount of liquid it contains . . .** ***without drilling or cutting it in any way?***

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WORLD PETROLEUM ABSTRACTS

Summaries of the Most Important Articles as Published in the Oil Press of the World Dealing with Technical and Economic Aspects of the Petroleum Industry—Edited by Dr. O. W. Willcox.

GEOLOGY

Classification of Oil Reservoirs.—H. R. Loorly, in BULLETIN AMERICAN ASSOCIATION PETROLEUM GEOLOGISTS, Vol. 27 (1943), No. 2, p. 224.

Quoting W. B. Wilson, it is again pointed out that there is on distinction made at present between an oil trap formed by the actual lensing-out, and disappearance from the stratigraphical column, of a particular reservoir bed, and a trap formed within the same bed by virtue of local variation in porosity, permeability, cementation, *et cetera*. This first case is undoubtedly a stratigraphic trap, but can this term be accurately applied to the second one?

The writer is of the opinion that this difficulty could be avoided by the introduction of another class of trap to include all cases covering varying physical and chemical properties of the constituent rock, and to call this class "Lithologic" traps.

There would thus be three types of oil reservoir according to the following geological classification.

1. Structural, including all traps formed by actual deformation of the earth's crust by either folding or faulting.
2. Stratigraphical, including all cases where there is an actual local disappearance of the reservoir bed from the geological column either against an unconformity of otherwise.
3. Lithological, including all cases where a variation in the physical or chemical properties of a particular bed renders it locally permeable.

GEOPHYSICS

Micromagnetics, a New Quantitative Geophysical Method—W. P. Jenny, in OIL WEEKLY, Vol. 108 (1943), No. 10, pp. 21-24.

The micromagnetic method is based on the fact that certain strata within the sedimentary column are strongly magnetic, others weakly magnetic, and others non-magnetic. This fact has been proved in recent years by the magnetic-core orientation method, by the examination of well cores, and by the interpretation of regional and local magnetic anamolies. Ready proof of the individual magnetic characteristics of different members of the stratigraphic column may be obtained by sticking a steel needle into the washed residues of well samples. The residues of samples from certain depths will contain sufficient magnetite to cover the needle, indicating the presence of a stratum that may contain enough magnetite to actively influence the magnetic field at the surface. The distribution of the magnetic material may safely be assumed to be consistent within limited regions, and that changes in the distribution will be of a regional rather than of a local nature. When structures have not been disturbed, the magnetic effect over the region may be constant, or show the effect of regional thinning, thickening, or dip. Local magnetic anomalies point to the existence of structural disturbances, faults, etc.

With the latest type of magneto-meter, which has an accuracy of at least one gamma, it is possible to make a new approach to micromagnetic explorations that should greatly increase their potentialities. With this accuracy a 100-foot closure would produce a local magnetic anomaly of 3 to 5 gammas; a 200-foot fault an anomaly of 6 to 10 gammas. Even in areas where no subsurface control exists it is possible to construct a micromagnetic relative structural contour map which represents a close and safe approach to subsurface conditions and corresponds to the time map of a seismic reflection survey of such areas. In regions where some subsurface control

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is available it is possible to go a step further and construct a sub-sea structural contour map. For instance, where the normal depth and depth of the Heterostegina zone is known from the data of three dry holes, this data may be correlated with a regional micromagnetic survey and a structural contour map on top of the Heterostegina may be plotted. With some modifications this quantitative method of interpretation may also be applied in regions where the basement complex is the main source of magnetic anomalies, and where the overlying formations are directly affected by disturbances of the basement, as for example, the Ordovician structures of West Texas.

As the author points out, although this quantitative aproach is relatively new, sufficient practical experience has been gained to establish it as sound in principle and of great potentialities.

DRILLING

Directional Redrilling of Piecement Type Dome Increase Recovery—J. Zaba, in OIL & GAS JOURNAL, Vol. 41 (1943), No. 36, pp. 31-33.

In this paper attention is called to the possibilities of obtaining more worthwhile production from old salt domes that have been regarded as drilled out, and now abandoned. Instances are cited to show that such abandonment has been premature and might have been postponed if the drillers had at their disposal the resources of modern directional drilling.

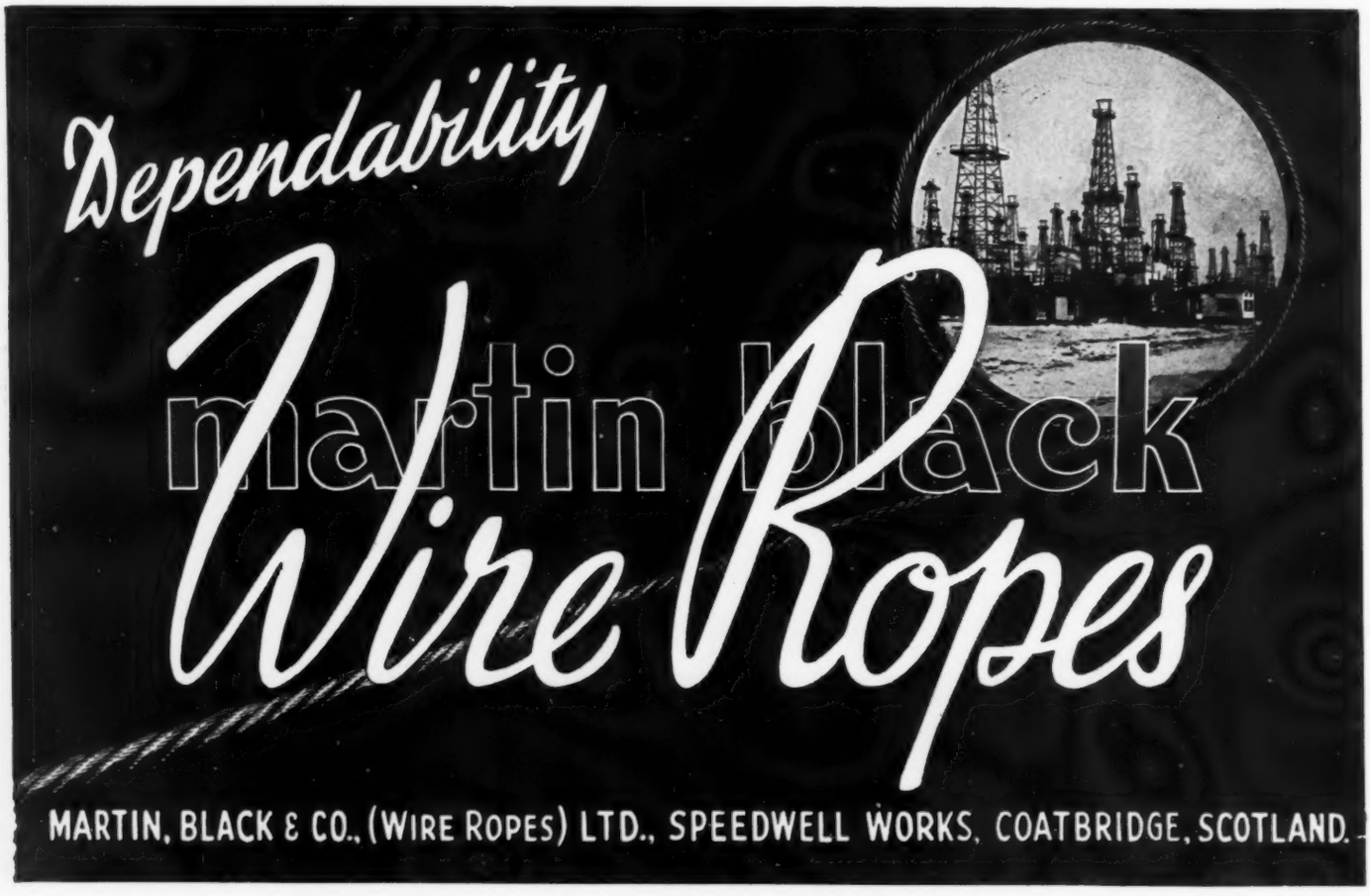
Conditions in such a field may present the following picture: The producing area is usually a narrow rim surrounding the salt mass with steep dips, faulting, and abrupt changes in the lithological character of the producing formations. For instance, three wells drilled to bottoms in a circle with a radius of 150 feet encountered these three sets of conditions: (a) a number of separate sands completely flooded with water; (b) a sand body capable of producing gas and oil; and (c) a complete absence of sands. This is a picture of confusion that might discourage the most optimistic operator. However, it is pointed out how new possibilities may be and have been opened up in the midst of such complexities.

The first step toward a campaign of directional redrilling an apparently drilled-out Gulf Coast salt dome field is a thorough study of the records of producing and abandoned wells on the property. This will give a general picture of the situation. The next step is recontouring the producing horizons, taking into consideration the actual position of the bottoms of the wells; this will necessitate securing directional surveys of as many wells as is reasonably possible; exploratory wells may be directionally drilled in chosen directions. With this information on corrected contours, it is interesting to observe how many contour anomalies tend to disappear, permitting a more or less rational location for the bottom of a new well, even though it may be immediately adjacent to an old dry hole. Various circumstances which may influence the decision are pointed out. Results are stated which demonstrate that new drilling in these complicated structures is not such a wild adventure as might be supposed. By applying directional drilling to an old dome field that was considered worked out over 8 years ago, some 3,000,000 bbl. of additional oil was recovered. In one case a shrewd interpretation of the data suggested a new well 50 feet from an old 4,743-foot dry hole; up to Nov. 1, 1942, the new hole had produced 136,707 bbl. in a sand at 4,100 feet that the other missed, and it is still capable of producing. In another case a dry hole was directionally redrilled and became a good producer and pumper with its bottom not more than 40 feet from the bottom of an abandoned old producer.

It is pointed out that under present wartime restrictions governing spacing such redrilling campaigns, particularly as regards new wells, is not feasible. However, this experience points to the possibility of a revival in piercement-type-dome oil fields of the Gulf Coast under a carefully planned procedure.

Experiments in the Substitution of Non-Metallic Pipe for Steel Well Casing—Frederick Squires, before AMERICAN INSTITUTE MINING METALLURGICAL ENGINEERS, New York Meeting, February, 1943.

The oil industry in normal times is a heavy consumer of steel, chiefly for casing. Steel being scarce, wide spacings of wells have been prescribed, which has resulted in some decline of production. The Illinois Geological survey has made an effort to find non-metallic materials capable of replacing steel as well casing. It was thought that if such materials were available and should prove practical, the principal necessity for putting a limit on drilling might be removed and adequate production of oil might be maintained. Two classes of pipe



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came into consideration for these experiments: (1) the well-known "fiber conduit" made of pitch and wood fiber, and (2) an asbestos-cement product known as "transite". Both these have been employed in ordinary line pipe service, or for electric cable conduits.

On the whole, the wood fiber pipe turned out to be not very promising. Transite has already seen service as liners for the bottom hundred-odd feet of oil wells in Pennsylvania. An experimental string 427 feet long was successfully installed in an Illinois well. At the time of writing this well had been in continuous operation for eight months and is in good condition. This test is quite suggestive, but the matter requires further collaborative study.

NATURAL GAS

Natural Gas Pipe-Line Dehydration—Henry N. Wade in MINES MAGAZINE, vol. 33 (1943), No. 5, pp. 237-241, 289.

In a general discussion of natural gas pipe-line dehydration the author quotes typical recent experience with various systems.

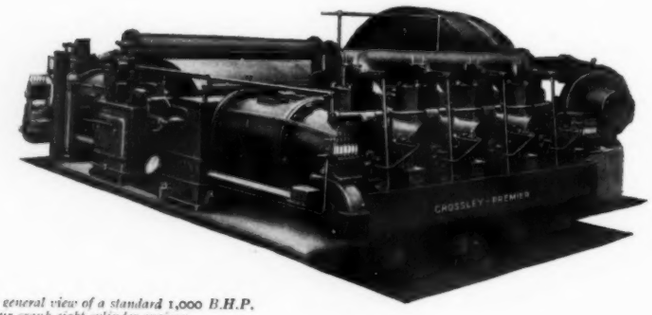
The largest plant still using calcium chloride as a dehydrating medium treats gas at a pressure of 500 p.s.i. at the outlet of an absorption plant, and a sulfur removal plant using the soda ash process. The average dewpoint depression accomplished is 20° F., which adequately protects the system against hydrate formation except under temporary and very unusual weather conditions. The chief operating trouble has arisen from occasional slugs of soda from the sulfur removal unit. Operation and maintenance costs are given as 21.8¢ per million cu. ft.

The operator of two diethylene glycol solution plants operating at pressures of 400 lbs. or slightly less reports glycol consumption of 0.22 and 0.501 lb. and the operating costs at 31.6 and 32.9¢ per million cu. ft. No corrosion in any part of the system is noted. Extremely satisfactory dehydration and hydrogen sulfide removal is reported from a mixture of monoethanolamine and diethylene glycol under the Girdler patents.

Another diethylene glycol plant operating at 300 p.s.i. with gas temperatures at more than 90° under heavy load conditions reports glycol consumption of 0.811 lb. per million cu. ft. during 1942. There was persistent trouble in maintaining packing rings on the pistons of the solution-circulation pumps, which brings out the fact that for this service plunger type pumps are to be preefrred to the packed piston type. This operator reports no corrosion or glycol decomposition, and no serious fouling or clogging.

The largest dehydration plant using diethyl glycol solution started late in 1940 with an operating pressure of about 500 lbs. Average loss of glycol is reported at slightly under 0.25 lb. per million cu. ft. A peculiar and not entirely explained case of corrosion is reported. Shortly after starting up, the seamless steel tubes in the solution heat-exchangers failed from corrosion, and showed deposits of ferrous oxide and sulfide, evidently derived from decomposition of mercaptans through the action of some unknown catalytic material. The temperature maintained in the base of the solution still was about 350° F. and the pressure 10 lbs. gage. On lowering the temperature to 280° F. and the pressure to 3 lbs. the trouble disappeared. Similar corrosion was noted with admirality bronze tubes in the still reboiler.

A combination sulfur removal and dehydration plant using a mixture of monoethanol and diethylene glycol reports the following facts: The plant has been in operation about 15 months treating gas



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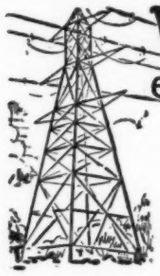

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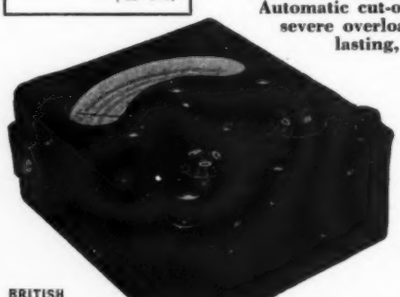

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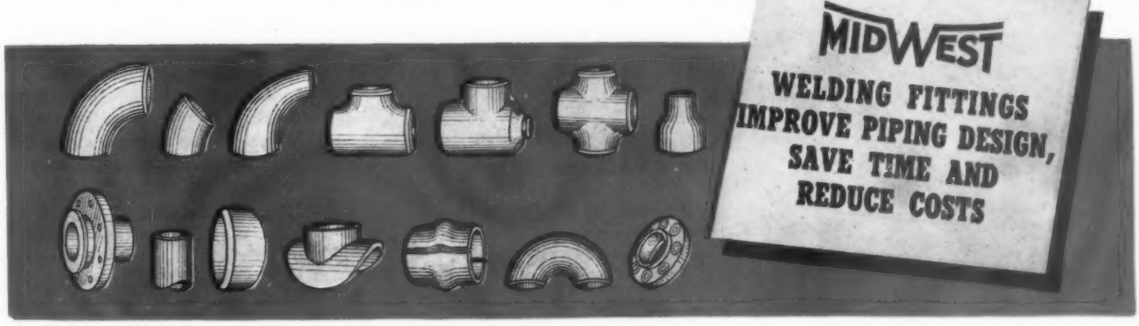

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containing 900 to 1,000 grains of hydrogen sulphide per 100 cu. ft. The gas is desulphurized and rehydrated to dewpoints of approximately 35° F. in a single contacting tower. Quantitative determinations of hydrogen sulphide in the outlet gas show negative up to a maximum of 0.2 grains per 100 cu. ft. No corrosion or other operating troubles have been reported. The very large amount of hydrogen sulphide removed from the gas is the equivalent at full load of about 14,000 lbs. per 24 hours of sulphur. The safe disposal of this large volume of poisonous gas is accomplished by burning it at the top of a mast about 100 ft. high. The sulphur dioxide resulting from the combustion is diffused enough to cause no difficulties around the plant. Several reports from plants using solid adsorbents like florite and activated alumina give only general overall operating results without costs or other details. The oldest of these plants went into operation early in 1940. The owners report entire satisfaction with the operation and state that the original bed of florite appears to be good for an indefinite service. The substance of these general reports indicates that the two forms of alumina now available for this purpose offer the most satisfactory performance that has been obtained by solid adsorbents.

USES

Pour-Point Stability of Treated Oils under Winter Storage Conditions—Caleb E. Hodges and A. Bruce Boehm, before NATIONAL PETROLEUM ASSOCIATION and WESTERN PETROLEUM REFINERS' ASSOCIATION. Tulsa, 1943.

It has been observed that during winter months certain motor oils that had been treated with pour-depressants were sometimes found solid in their storage containers at temperatures higher than those indicated by their A. S. T. M. pour points. For example, a 10-W motor oil made from a neutral-bright stock blend and paraflow had an A. S. T. M. pour point of —20°; this same oil in winter storage was found solid at 10°. This phenomenon is referred to as "pour reversion."

The authors offer a theoretical explanation which seems to accord with the facts. The solid point of a wax-bearing oil results from the formation of a wax-oil gel when the oil is cooled. Anything that would block the formation of this gel would lower the temperature of solidification. If the oil has been treated with paraflow, the first minute crystals that appear selectively adsorb the paraflow, which markedly changes their size and shapes; instead of growing and adsorbing oil, thus forming a gel, the crystals, by reason of the coating of adsorbed paraflow, are kept apart and thus the formation of a gel is inhibited.

On the other hand, if by some means or other the adsorbed paraflow should be released or removed from the wax crystals, the crystals would be free to adsorb the oil and thus form a gel. Once oil has been adsorbed on the wax, the subsequent readsorption and return of the paraflow the wax is blocked. This is demonstrated by blending 1 percent of paraflow in a +30° F. cloud oil, this blending being done at about 100° F.; the result was an oil which gave an A. S. T. M. pour point of —20°, while the same components blended at +25° had a +20° A. S. T. M. pour point.

An analogous condition is created when an oil treated with paraflow passes from a low storage temperature, where the wax particles are well inhibited, to a higher temperature. Immediately the adsorption equilibrium between adsorbed paraflow and paraflow in solution is displaced; some of the inhibitor leaves the crystals and goes back into solution; part of the wax is thus left free to adsorb oil and when the storage temperature falls again the return of the paraflow is blocked, and thereafter the solid point of the oil is higher than before.

Not all treated oils turn solid in storage, however, and it is desirable to have a routine laboratory procedure to determine the tendency of oils to "pour reversion." The authors have therefore developed an apparatus wherein oil samples are exposed to automatically produced cyclic changes in temperature over the range of +30° to —30°. Visual inspection of samples stored in their apparatus discloses which of them are subject to pour reversion. It has not been possible to correlate pour stability with any broad oil classification. Neutrals respond well to treatment but each must be tested with several concentrations to find the most stable blend. Inclusion of bright stock in a neutral oil-paraflow blend may radically change the stability characteristics of the oil. Use of a combination of Pennsylvania 150 neutral and paraflow together with mid-continent bright stock in amounts of 7 to 15 percent gave satisfactory stability.

GENERAL

New Latin-American petroleum periodical—Boletin del Instituto Sudamericano del Petroleo—Published by the executive committee of the INSTITUTO SUDAMERICANO DEL PETROLEO, Montevideo, Uruguay; edited by German E. Villar.

This publication is designed as a medium for the presentation and discussion of problems relating to the discovery, production and distribution of petroleum products in the South American continent, and to serve as the official organ of the I. S. A. P., which was recently organized by national petroleum associations of six South American countries.

The first number, which is dated April, 1943, contains four articles outlining the services which the I. S. P. A. expects to render to the South American continent; an article describing the petroleum refinery of the ANCAP near Montevideo; a description of the research laboratory of the YPF of Argentina, and information regarding the present petroleum industry of South America, including brief surveys of the industry in Argentina, Colombia, Chile, Ecuador, and Peru.

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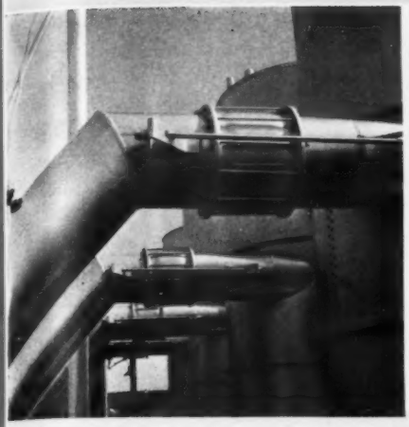

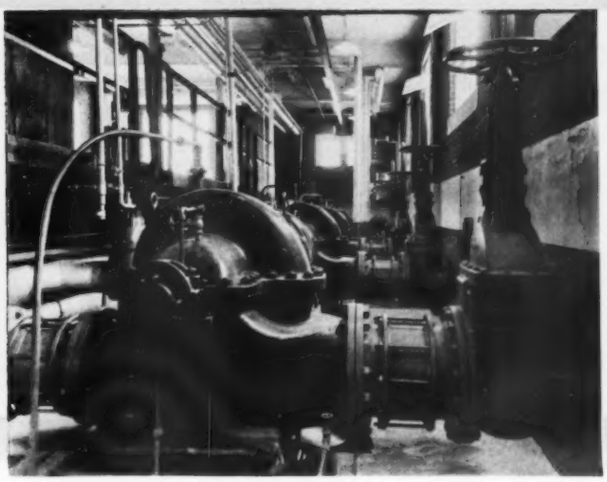

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Demonstration Plants for Synthetic Oil

(*Continued from page* 49)

bill and assured the committee that the proposal should have the "wholehearted cooperation" of the petroleum industry. He thought the day of synthetic liquid fuels was a long way in the future, but believed it would be "dangerous" to delay the program.

Brig. Gen. William E. R. Covell, chief of the new Fuels and Lubricants Division, QMC, approved the proposed legislation and revealed that more than half the total tonnage of supplies shipped to the Army overseas consists of petroleum products. In the case of North Africa he said they amounted to 65 per cent.

Dr. Gustav Egloff, research director of Universal Oil Products Co., differed sharply with predictions that domestic oil reserves face early depletion, but approved further government research into oil from coal.

"I'm not one of these prophets of immediate exhaustion," Dr. Egloff declared, adding that if we search hard enough we shall find vast deposits now unknown. "We've had these predictions of exhaustion for 85 years," he said, "They began two years after the drilling of the Drake well."

Dr. Egloff suggested that more immediate benefit would come from studies of secondary recovery methods, utilization of liquified gases and working of oil and tar sands than from experimentation with coal hydrogenation which he characterized as the most expensive of synthetic process both in cost and man-power. He said that the mining of oil sands would produce large amounts of oil at much less cost.

Bruce Brown, assistant deputy Petroleum Administrator for War, gave the committee some information on different processes of synthetic production and their relative costs.

"The total cost of producing gasoline by direct coal hydrogenation under war conditions," Mr. Brown said, "has been estimated at from 10 to 25 cents per U. S. gallon depending on rates of amortization and plant capacity. The Imperial Defense and Labor Committee report of Great Britain in 1928 showed a cost of 18 cents per gallon.

"W. S. Farish late president of Standard Oil of N. J. in 1942 testified before the Sub-Committee, House of Representatives, on gasoline from coal and estimated a total cost per gallon on a plant of approximately 3,000 barrels at about 23 cents by direct coal hydrogenation and 19 cents by the Fischer-Tropsch process. (The cost of the plant itself has been variously estimated; a present day approximate figure for a capacity of 3,000 b/d being of the order of 30,000,000). For a 30,000 barrel per day plant the estimate was 16 cents per U. S. gallon.

"With natural gas at five cents per 1,000 cubic feet it was estimated by Mr. Farish that the cost of gasoline production by the Fischer-Tropsch process would be about nine cents per gallon or possibly lower. Other estimates have been made as low as five cents per gallon so that with improvements resulting from research, development and operating experience this process may be competitive with crude oil at $2 per barrel or even less."

In the opinion of Robert P. Russell, executive vice president of the standard Oil Development Co., the use of coal in hydrogenation is the least efficient and most expensive of the synthetic processes.

"It has been my own belief," Mr. Russell told the Senators, "that if crude supplies should dwindle to a critical minimum, the next major source of petroleum products would probably be natural gas, tar sands and oil shale." Dr. R. R. Sayers, director of the Bureau of Mines and several members of the Bureau staff presented technical discussions of hydrogenation and other processes for the production of synthetic fuel.

At the conclusion of the hearings, the O'Mahoney group sought further information at sessions in Pittsburgh, Salt Lake City and Sheridan, Wyo. An early report on the bill is expected when Congress reconvenes September 14. Prospect of passage appears favorable, as no opposition is yet evident.

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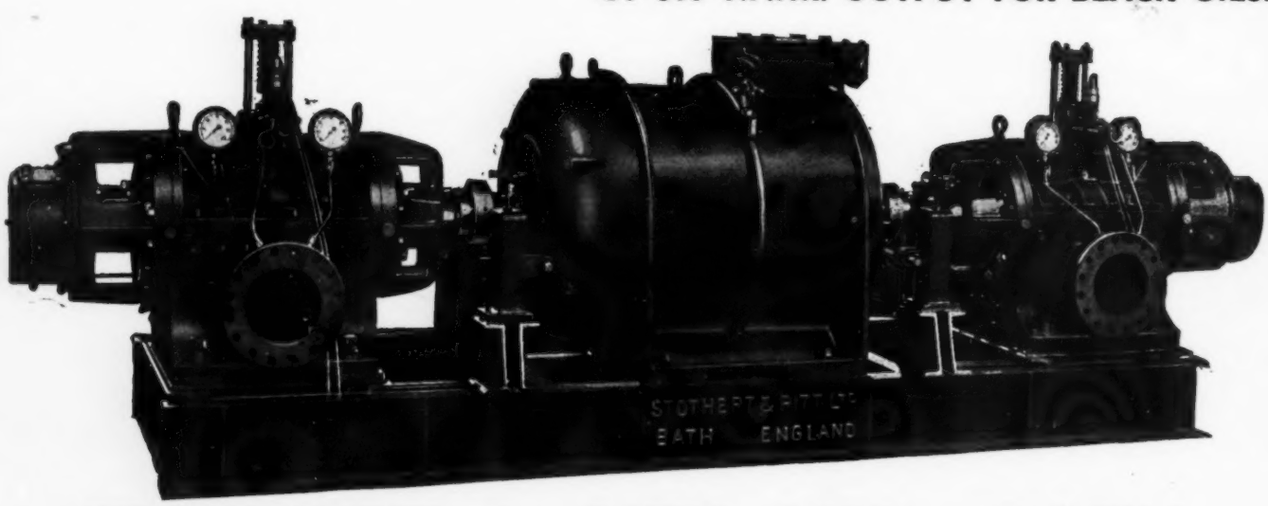

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